APPENDIX C
FISH AND WILDLIFE
COORDINATION ACT REPORTS

U.S. DEPARTMENT OF THE INTERIOR
AND
FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

SUPPLEMENTAL FISH AND WILDLIFE COORDINATION ACT REPORT

For the:

INTERIM OPERATING PLAN

Analysis of Alternative 7

Prepared by:

South Florida Field Office
Vero Beach, Florida
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Everglades National Park
Homestead, Florida
National Park Service

Submitted to:

U.S. Army Corps of Engineers
Jacksonville District
Jacksonville, Florida

September 28, 2001

United States Department of the Interior

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September 28, 2001

Colonel James G. May
District Commander, Jacksonville District
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RE: Supplemental Fish and Wildlife Coordination Act Report for the Supplemental Draft Environmental Impact Statement for the Interim Structural and Operational Plan and Interim Operating Plan; Broward, Miami-Dade and Monroe Counties, Florida

Dear Colonel May:

The U.S. Fish and Wildlife Service (FWS) and the National Park Service (NPS) have prepared this Supplemental Fish and Wildlife Coordination Act Report (CAR) for the Supplemental Draft Environmental Impact Statement (SDEIS) for the Interim Structural and Operational Plan (ISOP) and Interim Operating Plan (IOP), Broward, Miami-Dade and Monroe Counties, Florida. The SDEIS analyzes and evaluates the ISOP and a new Alternative 7 for the future IOP, which are intended to provide for meeting Endangered Species Act requirements for protection of the endangered Cape Sable seaside sparrow.

This Supplemental CAR is provided in accordance with the Fish and Wildlife Coordination Act of 1958 (48 Stat. 401, as amended: 16 U.S.C. 661 *et seq.*) and section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) and, together with the August 2, 2001, original CAR, constitutes the report of the Secretary of the Interior as required by section 2(b) of the FWCA. This Supplemental CAR does not constitute a biological opinion under section 7 of the Endangered Species Act. As discussed in meetings with you and your staff, FWS will prepare an amendment to our February 19, 1999, biological opinion covering your final selected alternative prior to your Record of Decision on the IOP.

Much of the information provided in this Supplement was included as an Addendum to our original August 2, 2001, CAR. This information has been reformatted and updated as a Supplement in order to clearly delineate those portions of our analysis that address issues covered in the U.S. Army Corps of Engineers' (Corps) SDEIS separately from portions of our analysis addressing issues covered in the Corps' February, 2001, Draft Environmental Impact Statement (DEIS). This will allow readers to directly review and compare the Corps' DEIS alongside our original August 2, 2001 FWCA Report, and the Corps' SDEIS alongside this Supplemental CAR.

If you have any questions regarding this Supplemental CAR, please contact us or have your staff contact Heather McSharry at 561/562-3909, extension 247, or Dr. Thomas Van Lent at 305/242-7804.

Sincerely,

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Maureen A. Finnerty
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Enclosure

cc:

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Executive Summary

This Supplemental Fish and Wildlife Coordination Act Report provides U.S. Fish and Wildlife Service (FWS) and National Park Service (NPS) analysis of issues addressed in the U.S. Army Corps of Engineers' (Corps) Supplemental Draft Environmental Impact Statement for the Interim Operational Plan (IOP). Our analysis of IOP issues addressed in the Corps' February, 2001, Draft Environmental Impact Statement is presented in our original August 2, 2001, Fish and Wildlife Coordination Act Report.

Analysis of Interim Structural and Operational Plan (ISOP) implementation revealed some significant limitations and unintended consequences that have led the FWS and NPS to conclude that these alternatives are not suitable for providing protections to the endangered Cape Sable seaside sparrow and it's critical habitat required by the Endangered Species Act (ESA). IOP Alternative 7 includes substantive measures addressing each of our concerns with the ISOP alternatives and was developed through a consensus negotiation process between the Corps, FWS, NPS and South Florida Water Management District (SFWMD). Based on this and on information regarding Alternative 7 performance provided to us by the Corps, the FWS and NPS conclude that the best currently available scientific and commercial information indicates that Alternative 7 is likely to comply with ESA requirements, and minimize adverse effects to other natural resources as compared to the ISOP and other IOP alternatives. Although the FWS and NPS continue to recommend the February 19, 1999, Reasonable and Prudent Alternative as the environmentally preferred alternative for the IOP, we find Alternative 7 acceptable and greatly appreciate the Corps and SFWMD's willingness to work out this agreement with us.

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Supplemental Fish and Wildlife Coordination Act Report

1.0 Analysis of ISOP

The August 2, 2001 Fish and Wildlife Coordination Act Report (CAR) contains a complete analysis of the Interim Structural and Operational Plan (ISOP) alternatives. Rather than reproduce this analysis in this supplement, we will refer the reader to specific sections of the August 2, 2001 CAR. The ISOP is described in the Draft Environmental Impact Statement (DEIS) as Alternative 1, or the "No Action" alternative. Section 4.2.2.1 on page 63 of the CAR contains a complete description of the operational rules and primary water management features of the ISOP. Section 4.4, beginning on page 84, contains an analysis of the hydrologic impacts of the ISOP. These hydrologic impacts are assessed in four different methods. First, there is a review of the primary hydrologic impacts as predicted by the South Florida Water Management Model (SFWMM). This is followed by a MODBRANCH analysis in Section 4.4.1. The third analysis involves the application of analytical element groundwater models, found in Section 4.4.2. The fourth method is the analysis of the observed hydrologic data, which is found in Section 4.5, beginning on page 109. Included in Section 4.5 is a detailed analysis of the observed hydrologic effects in the sparrow habitats. Section 4.6 is a comparison of the ISOP to the Reasonable and Prudent Alternative (RPA), which is followed in Section 4.7 (p.157) by an examination of the ecological effects of the ISOP.

Chapter 5 (p.167) of the CAR also contains detailed analyses on the expected impacts to federally-listed threatened and endangered species for several of the alternatives presented in the DEIS. The ISOP is specifically examined as "Alternative 1"; the analysis related to the ISOP is interleaved with the other provided alternatives. Similarly, Chapter 6 (p. 205) examines the hydrologic and ecological effects of several draft EIS alternatives; the ISOP (Alternative 1) analysis in interleaved throughout the chapter.

The analysis presented in the CAR, including the monitoring of actual implementation of the ISOP, revealed that some aspects of the ISOP did not function in the way the U.S. Army Corps of Engineers (Corps) expected them to based on their (SFWMM) modeling and other design analyses, and revealed some additional adverse biological impacts to Cape Sable seaside sparrow (CSSS) habitat and other areas that were not anticipated. Additionally, actual implementation of the ISOP included some significant changes in operations that were not included in the SFWMM at all. These results of actual monitoring led the Fish and Wildlife Service (FWS) and National Park Service (NPS) to conclude that the ISOP, and other similar operations proposed as Interim Operating Plan (IOP) Alternatives 1, 5 and 6 and under various other names, were unlikely to meet Endangered Species Act (ESA) requirements for the CSSS and were likely to cause significant additional adverse impacts to other natural areas. The Corps initial development of IOP alternatives, as presented in the DEIS, did not take all of these lessons learned from actual implementation into account. Accordingly, FWS and NPS expressed their concern and suggested to the Corps that IOP development should be viewed as an opportunity to acknowledge and correct the significant limitations of the SFWMM and unintended consequences of actual ISOP implementation.

2.0 Analysis of Alternative 7

In the Supplemental Draft Environmental Impact Statement (SDEIS), the Corps presented a new alternative, Alternative 7. This alternative was developed months after release of the Draft IOP EIS, the Corps agreed to work with FWS, NPS and South Florida Water Management District (SFWMD) to include lessons learned from the ISOP into an adjusted IOP alternative. These discussions were successful, and FWS and NPS are pleased to express our support for the resulting Alternative 7.

During the discussions on how the modify the DEIS alternatives, the Corps continued to model possible alternatives. The Corps provided the information to the FWS, NPS, and SFWMD for their review. This review was necessarily preliminary, as time constraints did not allow a complete and thorough analysis equivalent to that found in the CAR of August 2, 2001. The information provided by the Corps formed the basis for the current NPS and FWS support for Alternative 7. The information that the Corps provided upon which the NPS and FWS based their preliminary assessments will be included in the Final Supplemental EIS.

This Supplemental CAR contains a greatly abbreviated preliminary analysis. Our analysis is presented as a discussion of how Alternative 7 successfully addresses each of our recommendations for improvement of the draft IOP EIS alternatives (see Summary and Conclusions section). Table 1.1 provides the precise operational rules for Alternative 7 normal operations. Flood control emergency operations for Alternative 7 are provided in the attached *Pre-Storm / Storm / and Storm Recovery Operations for the South Dade Conveyance System* document.

2.1 Response to Recommendations for Improvement of IOP Alternatives

2.1.1 *Recommendation:*

"Although FWS and NPS fully support building the second S-332B retention area and believe that this feature will reduce expected adverse effects, canal stage criteria must also be significantly adjusted from those presented in Alt6P1 in order to eliminate additional adverse effects resulting from flooding of some CSSS habitat areas and over-drainage of others".

Alt7 Response: Alternative 7 includes the second S-332B retention area and addresses additional adverse effects resulting from flooding of some areas in several ways: 1) canal stage criteria are increased as compared to the other alternatives, reducing the volume of water pumped into Everglades National Park (ENP) and CSSS habitats at point sources; 2) operations of S-332B will not be allowed to cause overflow of the S-332B retention area(s) into CSSS habitat except in precisely-defined emergency situations; 3) South Dade Conveyance System (SDCS) operations will not be allowed to provide additional capacity for S-335 flood control operations

Table 1.1. IOP Alternative 7 Operations

	No WCA-3A Regulatory Releases to SDCS or Shark Slough	**WCA-3A Regulatory Releases to SDCS**
Regulation Schedule	Deviation schedule for WCA-3A as specified by USACE including raising Zone D to Zone C from Nov 1 to Feb 11. No deviation in WCA-2A regulation schedule.	Deviation schedule for WCA-3A as specified by USACE including raising Zone D to Zone C from Nov 1 to Feb 11. No deviation in WCA-2A regulation schedule.
S-343 A/B and S-344	Closed Nov 1 to July 15 independent of WCA-3A levels.	Closed Nov 1 to July 15 independent of WCA-3A levels.
S-12 A/B/C/D	S-12A closed Nov 1 to Jul 15; S-12B closed Jan 1 to Jul 15; S-12C closed Feb 1 to Jul 15; S-12D no closure dates. Follow WCA 3A regulation schedule after Jul 15. Note: If closure requires regulatory releases to SDCS then switch to operations for regulatory releases to SDCS.	S-12A closed Nov 1 to Jul 15; S-12B closed Jan 1 to Jul 15; S-12C closed Feb 1 to Jul 15; S-12D no closure dates. Follow WCA 3A regulation schedule after Jul 15.
S-333: G-3273 < 6.8' NGVD Degrade the lower four miles of the L-67 extension	55% of the rainfall plan target to NESRS and 45% through the S-12 structures	55% of the rainfall plan target to NESRS, plus as much of the remaining 45% that the S-12s can't discharge to be passed through S-334; and subject to capacity constraints, which are 1350 cfs at S-333, L-29 maximum stage limit, and canal stage limits downstream of S-334.
S-333: G-3273 > 6.8' NGVD	Closed	Match S-333 with S-334 flows
L-29 constraint	9.0 ft	9.0 ft
S-355A&B	Follow the same constraints as S-333. Open whenever gradient allows southerly flow.	Follow the same constraints as S-333. Open whenever gradient allows southerly flow.
S-337	Water Supply	Regulatory releases as per WCA-3A deviation schedule.
S-151	Water Supply	Regulatory releases as per WCA-3A deviation schedule.
S-335	Water Supply Allow releases through S-335 if there is downstream capacity consistent with pre-ISOP operations. "Downstream capacity" would not include capacity created by pumping at S-332B or S-332D and not trigger opening S-18C at 2.6. Note: It is recognized that under these conditions operations of S-335 would be infrequent.	When making regulatory releases through S-151, match S-335 outflows with inflows from S-151 and S-337 Use S-333/334 before S-335

Table 1.1 cont.

	No WCA-3A Regulatory Releases to SDCS or Shark Slough	WCA-3A Regulatory Releases to SDCS
S-334	Closed	Pass all or partial S-333 flows Depending on stage at G-3273
S-338	Open 5.8 Close 5.5	Open 5.8 Close 5.4
G-211	Open 6.0 Close 5.5	Open 5.7 Close 5.3
S-331	Angel's Criteria	Angel's Criteria
S-332B Note 1: There will be two 125-cfs pumps and one 75-cfs pump directed to the second detention basin. The remaining two 125-cfs pumps will be directed to the first detention basin. If possible, the 75-cfs pump will be designed so that it can be directed to either basin. Note 2: A new indicator will be established for Subpopulation F and a new gauge will be installed about ½ mile west of the weir on the western edge of the retention area. Pumping will cease after 180 days of above ground hydroperiod at the new gauge during a year that runs from July 15th to July 14th. After water levels recede below ground, pumping can be resumed at a rate that maintains water elevations below ground at the gauge until the beginning of the next year.	Pumped up to 250 cfs* from Jun through Feb; and 125 cfs from Mar through May. On 5.0 Off 4.7** *This pumping rate is based on the assumption that there will be no overflow into the Park. If there is overflow into the Park, the pumping rate will be adjusted. **If, after the first 30 days of operation, there is no observed drawdown at the pump, this stage level will be raised to 4.8	Pumped up to 250 cfs* from Jun through Feb; and 125 cfs from Mar through May. On 4.8 Off 4.5 *This pumping rate is based on the assumption that there will be no overflow into the Park. If there is overflow into the Park, the pumping rate will be adjusted to eliminate overflow.
S-332B Seepage Reservoir	400 acres with no overflow to the west	400 acres with no overflow to the west
S-332D	Pumped up to 500 cfs from Jul 16 (or the end of the breeding season, as confirmed by FWS) to Nov 31; 325 cfs from Dec 1 to Jan 31; and 165 cfs* from Feb 1 to Jul 15. Meet Taylor Slough Rainfall formula (No L-31W constraint) On 4.85 Off 4.65 *New information will be sought to evaluate the feasibility of modifying the 165 cfs constraint	Pumped up to 500 cfs from Jul 16 (or the end of the breeding season, as confirmed by FWS) to Nov 31; 325 cfs from Dec 1 to Jan 31; and 165 cfs* from Feb 1 to Jul 15. Meet Taylor Slough Rainfall formula (No L-31W constraint) On 4.7 Off 4.5 *New information will be sought to evaluate the feasibility of modifying the 165 cfs constraint

Table 1.1 cont.

	No WCA-3A Regulatory Releases to SDCS or Shark Slough	WCA-3A Regulatory Releases to SDCS
S-332	Closed	Closed
S-175	Closed	Closed
S-194	Open 5.5 Close 4.8	Operated to maximize flood control discharges to coast Open 4.9 Close 4.5
S-196	Open 5.5 Close 4.8	Operated to maximize flood control discharges to coast Open 4.9 Close 4.5
S-176	Open 5.0 Close 4.75	Open 4.9 Close 4.7
S-177	Open 4.2 (see S-197 open) Close 3.6	Open 4.2 (see S-197 open) Close 3.6
S-18C	Open 2.6 Close 2.3	Open 2.25 Close 2.00
S-197	If S-177 headwater is greater than 4.1 or S-18C headwater is greater than 2.8 open 3 culverts If S-177 headwater is greater than 4.2 for 24 hours or S-18C headwater is greater than 3.1 open 7 culverts If S-177 headwater is greater than 4.3 or S-18C headwater is greater than 3.3 open 13 culverts Close gates when all the following conditions are met: 1. S-176 headwater is less than 5.2 and S-177 headwater is less than 4.2 2. Storm has moved away from the basin 3. After Conditions 1 and 2 are met, keep the number of S-197 culverts open necessary only to match residual flow through S-176. All culverts should be closed if S-177 headwater is less than 4.1 after all conditions are satisfied.	If S-177 headwater is greater than 4.1 or S-18C headwater is greater than 2.8 open 3 culverts If S-177 headwater is greater than 4.2 for 24 hours or S-18C headwater is greater than 3.1 open 7 culverts If S-177 headwater is greater than 4.3 or S-18C headwater is greater than 3.3 open 13 culverts Close gates when all the following conditions are met: 1. S-176 headwater is less than 5.2 and S-177 headwater is less than 4.2 2. Storm has moved away from the basin 3. After Conditions 1 and 2 are met, keep the number of S-197 culverts open necessary only to match residual flow through S-176. All culverts should be closed if S-177 headwater is less than 4.1 after all conditions are satisfied.

in excess of capacity provided during Test 7 Phase I implementation; and, 4) a trigger will prevent further S-332B operations if the adjacent CSSS habitat experiences hydroperiods greater than 180 days. Overdrainage of areas adjacent to the SDCS canals is addressed through restoring canal stage criteria to Test 7 Phase I levels or higher when regulatory releases from Water Conservation Area (WCA) 3A are not being brought around to the SDCS. Hydroperiods in the CSSS habitats adjacent to the SDCS will be increased beyond Test 7 Phase I hydroperiods by carefully controlled pumping into these habitats when WCA-3A water is being brought around. Canal level criteria during periods when WCA-3A water is brought around are only slightly lower than Test 7 Phase I levels, reducing seepage losses that would otherwise result in a net reduction in hydroperiods in some areas. Hydroperiods in CSSS sub-population E will be enhanced through degradation of the lower portion of the L-67E levee, which should allow more S-12D flows to move towards this habitat area. Additionally, the L-67E change should increase the getaway capacity for S-12D, potentially improving the IOPs ability to alleviate high water situations in WCA-3A and potentially enhancing water flows and volumes in Shark Slough and the Shark Slough estuaries.

2.1.2 *Recommendation:*

"The "Pre-storm drawdown" operations for non-tropical events should not be included in the final selected plan".

Alt7 Response: Alternative 7 does not include pre-storm drawdown operations for non-tropical events, and operations for tropical events have been precisely defined to include operations that have potential adverse effects on CSSS habitats only during emergencies.

2.1.3 *Recommendation:*

"S-334 should be the primary mode of routing WCA-3A regulatory flows to the SDCS. S-335 should only be operated to route excess flows from WCA-3A via S-337, or when needed for water supply during the dry season. S-332B and S-332D should only provide downstream capacity for S-335 flows that is equal to the flow from S-337. The capacity of S-333 should be extended beyond 1350 cfs by providing for additional reinforcement downstream of the structure".

Alt7 Response: In Alternative 7, S-334 will be the primary route for WCA-3A regulatory flows to the SDCS, with S-335 used as a secondary route for these flows. When WCA-3A flows are not being routed to the SDCS, S-335 will only be opened for water supply or when there is downstream capacity as it was defined during Test 7 Phase I implementation. As part of Alternative 7, the Corps will request authorization to provide for additional reinforcement downstream of S-333. Releases beyond 1350 cfs would occur if and when it can be demonstrated that such releases would not adversely impact private property.

2.1.4 *Recommendation:*

"S-332B detention area should not be allowed to overflow except under very limited emergency circumstances".

Alt7 Response: In Alternative 7, the S-332B retention area(s) will only be allowed to overflow into ENP and CSSS habitat under limited emergency circumstances as defined in the attached *Pre-Storm / Storm / and Storm Recovery Operations for the South Dade Conveyance System* document. Otherwise, S-332B pumping will be reduced or stopped to avoid overflow into the CSSS habitat.

2.1.5 *Recommendation:*

"Improvements in the SFWMM and the MODBRANCH model should be expedited for the Combined Structural and Operational Plan (CSOP) effort to better represent alternatives that include effects due to local sources and small retention areas, such as S-332B. Results of hydrologic monitoring and analysis presented in Chapter 4 should be considered in development of additional IOP alternatives".

Alt7 Response: Several aspects of Alternative 7 were designed using results of monitoring of actual ISOP operations analyzed in Chapter 4. The Corps has agreed to used improved SFWMM and MODBRANCH modeling for the CSOP.

2.1.6 Recommendation:

"Operations for the IOP should be detailed in an Operations and Maintenance Manual. Agreement should be reached between Department of the Interior (FWS and NPS), Corps and SFWMD that this manual reflects the operations as specified in the Final EIS. The manual should include provisions for monitoring and emergency operations, as well as mechanisms for dispute resolution, modifications as a result of new information to assure compliance in a manner satisfactory to all agencies".

Alt7 Response: The Corps has agreed to use a collaborative approach to reach consensus with NPS, FWS and SFWMD on IOP operations.

2.1.7 *Recommendation:*

"Mitigative measures for regulatory releases into the SDCS, such as lowering canal stages and increased pumping, should be taken only while making regulatory releases".

Alt7 Response: In Alternative 7, lowered canal stages and increased pumping will only be implemented when WCA-3A regulatory releases are being brought around to the SDCS, except under limited emergency circumstances defined in the *Pre-Storm / Storm / and Storm Recovery Operations for the South Dade Conveyance System* document.

2.1.8 *Recommendation:*

"S-332B operation should be regulated by water levels in the sub-population F habitat to preclude adverse effects to the CSSS habitat".

Alt7 Response: Alternative 7 includes a trigger that will prevent further S-332B operations if the adjacent CSSS habitat experiences hydroperiods greater than 180 days.

2.1.9 *Recommendation:*

"S-355A and S-355B should be operated to avoid adverse impacts to WCA-3B and Northeast Shark Slough. S-355A and S-355B should not be open when water levels in the headwater are less than the tail-water water levels".

Alt7 Response: Alternative 7 includes S-355A and B operations that will open these structures only when water levels in the headwater are less than the tail-water water levels".

3.0 Threatened and Endangered Species

3.0.1 Cape Sable seaside sparrow

As explained above, Alternative 7 includes features that address each of the concerns that led FWS to conclude that the ISOP and draft IOP EIS alternatives would not likely meet ESA requirements for the sparrow. RPA hydroperiod and nesting habitat availability requirements for sub-population A are provided to the maximum extent possible via previously agreed operations of the S-12s and related structures, as documented in Chapter 5. For sub-populations C and D, Alternative 7 operations should provide biological conditions necessary to avoid jeopardizing the CSSS' continued existence since the S-335 operations that likely delivered too much water to sub-population D have been eliminated. For sub-population F and other natural areas adjacent to L-31N that need to be managed to reduce fire risk for CSSS habitats, Alternative 7's increased canal stages, additional S-332B retention area, and limits on S-332B pumping and overflow should provide biological conditions in these areas equivalent to those expected under the RPA. For sub-population E, degradation of the lower portion of the L-67E levee, combined with reduced seepage losses that should result from Alternative 7's higher canal stages, should provide biological conditions in this area equivalent to those expected under the RPA.

For the sub-population E and F habitats, the SFWMM results for Alternative 7 may not show a match to the RPA02 model run. This is to be expected and is not a concern for FWS because we know that the SFWMM model does not provide an accurate representation of S-332B operations. Instead of relying on the inaccurate SFWMM model results to design S-332B operations, the Corps, SFWMD, NPS and FWS relied on actual monitoring data, experience with actual operation of the SDCS and our combined best professional judgement to design S-332B operations for Alternative 7.

3.0.2 Other listed species

For the wood stork, snail kite, West-Indian manatee and American crocodile, Alternative 7 should maintain or improve habitat suitability as compared to the ISOP and draft IOP EIS alternatives. Elimination of the S-335 drainage effects on WCA-3B, and increased getaway capacity at S-12D created by the L-67E modifications may even provide for some improvement in wood stork and snail kite habitats in WCA-3 and Shark Slough and manatee and crocodile habitats in the Shark Slough estuaries. Any adverse effects to these species should fall within the side-boards of the February 19, 1999, Biological Opinion and are therefore covered by that document. Construction of the second S-332B retention area could cause some adverse effects to the eastern indigo snake. However, the Corps will implement standard indigo snake protection construction protocols consistent with the February 19, 1999, biological opinion, so no additional adverse effects are anticipated. Construction of the second S-332B retention area may also affect the Florida panther since this area has received occasional panther use. Any adverse effects associated with this will be handled through additional ESA consultation, to be completed prior to a Record of Decision on the IOP.

4.0 Environmentally Preferred Alternative

FWS and NPS continue to recommend the RPA as the environmentally preferred alternative because it continues to provide the most balanced and overall ecological benefits. However, Alternative 7 is an acceptable alternative to the RPA because the best currently available scientific information indicates that it will likely meet ESA requirements for the CSSS.

5.0 Summary and Conclusions

The best currently available scientific and commercial information indicates that the ISOP and first draft IOP EIS alternatives are not likely to comply with ESA requirements. However, the best currently available scientific and commercial information indicates Alternative 7 is likely to comply with ESA requirements, and minimize adverse effects to natural resources as compared to the ISOP and first draft IOP EIS alternatives. Although the FWS and NPS continue to recommend the RPA as the environmentally preferred alternative for the IOP, we find Alternative 7 acceptable and greatly appreciate the Corps and SFWMD's willingness to work out this agreement with us.

Attachment 1

Pre-Storm / Storm / and Storm Recovery Operations for the South Dade Conveyance System

This document provides criteria to be used in preparing the South Dade Conveyance System (SDCS) / Miami-Dade County for forecasted storm events. The SDCS is composed of L-31N, L-31W, and C-111 canal system and control structures. Currently, for the East Coast Canal System, the canal system and control structures to the east of L-31N, the South Florida Water Management District (SFWMD) implements canal drawdown operations based on impending rainfall events. The goal for the SDCS is to develop a similar set of canal drawdown operating criteria which seek to balance the needs of the natural system with the authorized purposes of the Central and Southern Florida (C&SF) Project, which is multipurpose in scope and includes flood control and water supply.

The hurricane season is from June through November. When there are tropical depressions, tropical storms, and/or hurricanes in the Atlantic/Caribbean Basin, the National Hurricane Center (NHC) issue tropical cyclone public advisories, forecast advisories, forecast discussions, and strike probability forecasts* every 6 hours.

The SFWMD employs meteorologists who evaluate each tropical event and prepare average forecast errors using Hydrometeorologic Prediction Center (NPC) forecast tracking maps. The average forecast error means when the HPC has forecasted a specific track and the cyclone could end up anywhere in that "swath" within the next 72 hours with around a 60% confidence level. The average forecast error swath is based on the 10-year average of forecast errors.

The SFWMD Operations Control Division has defined operational procedures to be implemented depending on the timing or amount of advance warning prior to the onset of tropical storm force winds. The U.S. Army Corps of Engineers (Corps) also has defined in the Master Water Control Manual for each part of the C&SF Project a water control plan with instructions for pre-storm operations for structures around Lake Okeechobee and the Water Conservation Areas. The SFWMD operational procedures are termed "Conditions", the specific operating procedures for these conditions will be described in further detail in this document. Conditions are briefly summarized as follows:

- Condition 4, 72 – 48 hours prior to the impact of tropical storm force winds, is earliest level of preparation when the system is evaluated and initial adjustments made to operations depending on the forecast and nature of the storm. Coordinate with the Corps and local drainage districts

- Condition 3, 48 – 24 hours prior to the impact of tropical storm force winds, continue pre-storm operations and coordination with the Corps and local drainage districts.

- Condition 2, 24 – 12 hours prior to the impact of tropical storm force winds, bring telemetry-controlled sites to final pre-storm configuration, establish alternate emergency control station if necessary.

The remaining levels of preparation are Condition 1, 12 – 0 hours prior to the impact of tropical storm force winds; During the event; and Recovery after the event. It is important to note that some storm events do not allow for the full condition 4 with even 48 hours of advance warning.

It is important to emphasize that the C&SF Project is multi-purpose in design, and that pre-storm operations may not prevent flooding, such as experienced after Hurricane Irene in October 1999 or the no name storm in October 2000. The condition of the groundwater system at the time of a storm event is significant and is highly dependent on the amount and extent of rainfall that has already occurred prior to subsequent events. Further, there are areas of Miami-Dade County, and South Florida in general, which are at low elevations and for which no amount of drawdown can prevent flooding depending on the amount and extent of the event. The water levels discussed in this document are target levels and may not be attainable.

During the Cape Sable seaside sparrow (CSSS) nesting season, March 1 through July 15, or until nesting success, as defined in the Fish and Wildlife Service February 19, 1999 Final Biological Opinion, has been met, pumping at S-332D and S-332 is limited to 165 cfs. This constraint on pumping may limit the ability to implement pre-storm operations. At this time, the Corps Hydrologic Investigation Section is preparing modeling to determine possible impacts to sparrow nesting or implementing pre-storm operations.

Notification and Briefing Process

The Executive level will be briefed prior to initiation of pre-storm operations. This may occur prior to 72 hours or as soon as the average error forecast swath shows South Florida to be likely to be in the path of a storm. Obtaining Executive level approval is important in order to demonstrate to interested parties, such as the Fish and Wildlife Service (FWS) and the National Park Service (NPS), that operations were not arbitrary or capricious and that possible impacts to the sparrow or to the natural system were considered; however, in order to maintain the multi-purpose functioning of the C&SF Project, flood control operations were necessary.

1. Conditions 4 and 3 (24 to 72 Hours Prior to Storm Conditions)

Based on the Executive level orders, up to 72 hours in advance of a storm.

[1] {For the period 1989-1998, the average location error by forecast period was 55 statute miles at 12 hours, 102 miles at 24 hours, 147 miles at 36 hours, 164 miles at 48 hours and 278 miles at 72 hours. The strike probability forecast indicate the statistical chance that the tropical cyclone center will pass within 75 statue miles of a specified location within 3 days of the initial forecast time. The maximum strike forecast probabilities are 10-15% at 72 hours, 20-25% at 48 hours, 25-35% at 36 hours, 40-50% at 24 hours, an 75-85% at 12 hours.}

Drawdown Implementation:

Between 24 and 72 hours before tropical storm conditions in Miami-Dade County, the following target water levels are set for the SDCS (Table 1). The initiation of the pre-storm drawdown criteria would be triggered when Miami-Dade County is within the average error forecast swath as developed by the NPC. These pre-storm drawdown levels are not less than the level at which water supply deliveries are made during dry periods, that is 1.5 ft below optimum canal levels, except the reach north of G-211, which is 1.0 ft below current, normal operating levels. These levels are target levels and may not be attainable.

Sequence for Achieving Target Levels

In an effort to achieve the specified drawdown targets, a sequence of operational actions is recommended as described in Table 2. The goal is achieve one target before proceeding the next sequence, however, it may not be possible to achieve the target level and operations will proceed

Table 1. Target water levels for the SDCS.

Canal	Reach	Target Level for Draw-Down (ft)
L-31N	G-211 to S-331	4.0*
L-31N	S-331 to S-176	4.0
L-31W	S-174 to S-175	No target
C-111	S-176 to S-177	3.0
C-111	S-177 to S-18C	2.0
C-111	S-18C to S-197	No change**

* If Angel's well is 5.5 ft-NGVD or below, then 4.0 would be the target, otherwise, 3.5 ft-NGVD at the headwater of S-331 will be the target.

** Operation as specified in the SFWMD structure book for S-197

Table 2. Sequence of operation action.

Sequence	Canal	Reach	Target Draw-Down Level (ft)
1	L-31N	S-331 to S-176	4.0
	C-111	S-176 to S-177	3.0
2	L-31N	G-211 to S-331	4.0*
	L-31N	S-335 to G-211	5.0

* If Angel's well is 5.5 ft-NGVD or below, then 4.0 would be the target, otherwise, 3.5 ft-NGVD at the headwater of S-331 will be the target.

as based on the best available information at the time:

S-332B

Operational criteria are being developed to meet the Reasonable and Prudent Alternative (RPA) requirements. The criteria will take into account pre-storm and storm operations, except emergency deviations that must always be dealt with on a case-by-case basis. S-332B is a part of the C&SF Project, which is multipurpose in scope. While S-332B allows flexibility to operate the C&SF Project to better meet the needs of the CSSS it may also be used for meeting other project purposes such as flood control.

During pre-storm operations, the criteria for operation of S-332B would be the same as under normal operations, however, the notification procedure is to take place prior to changes in the upstream or downstream structural operations. Refer to the notification and briefing process section of this document regarding briefing the Executive level prior to initiating pre-storm operations.

S-197

No change is suggested in the operational criteria for this structure during Condition 4. The operational criteria is defined the SFWMD structure book for S-197.

2. Condition 2 and 1 (12 to 24 Hours Prior to Forecast arrival of tropical storm force winds).

Continue operations as in Condition 4 and 3, but with the following considerations:

S-332B

Pumps are secured for safety reasons. Personnel should move to S-332D for protection from tropical storm force winds, and to await resumption of operations at S-332B.

S-197

Operation of this structure requires mobilization of field personnel and equipment to operate the gates. It is not safe to operate this structure during storm conditions. Consequently, depending on conditions, three gates may be opened at Condition 1.

3. Recovery (Conditions immediately after the storm ends or if the storm forecast changes such that Dade County is no longer likely to be affected.)

Table 3.

Rising Water Level (ft)	Discharge (cfs)	Falling Water Level (ft)	Rated Discharge (cfs)
4.7	75*	5.0	450
4.9	200**	4.9	325
5.0	325	4.8	200**
5.1	450	4.7	75*
5.2	575	4.2	0

* Start with 125-cfs pump if 75-cfs pump is not operational
** This will cause overflow of the weir in the retention area

Table 4.

Structure	Status
S-331	Secure. Do not operate during storm.
S-332B	Secure. Personnel move to S-332D office area during storm.
S-332D	Continue pumping. Office area is hardened.
S-175	Keep closed
S-197	Consideration to be given to open 3 gates

Operations during Recovery consist of: 1) Maximizing discharges at water control structures to minimize flooding and 2) make the transition back to operational regime in place prior to the storm.

Operations may also be returned to levels prior to implementing pre-storm operations as soon as the Miami-Dade County is no longer within the average forecast error swath.

Plan for Worst Case: Recovery would be necessary if storm conditions result in significant rainfall in the Miami-Dade County area. The target for operations would be to return to operational regime in place prior to the storm. However, use of water control structures (e.g., S-175, S-332B) under emergency flood control mode would begin or continue until Recovery is complete. The following operations (Table 5) are suggested to continue to operate in emergency flood control mode:

Sequence for Achieving Normal Operating Ranges

It is not possible to describe the sequence of operational actions during Recovery prior to a particular storm event. The sequence of operational actions will depend largely on the rainfall dis-

Table 5. Suggested operations to continue in emergency flood control mode.

Structure	Status
S-331	Pump when downstream conditions allow
S-332D	Continue to pump
S-175	Use of this structure would be on a case-by- case basis with concurrence from the Department of Interior.
S-197	Open depending on conditions
S-332B	Resume pumping according to proposed operational criteria. Unless ENP and FWS concur, weir may overflow for no more than one week.

tribution and rainfall amounts resulting from the storm.

4. Back to Normal Mode (Operational regime in place prior to the storm)

The following conditions must be met before ceasing emergency flood control mode and resuming normal mode:

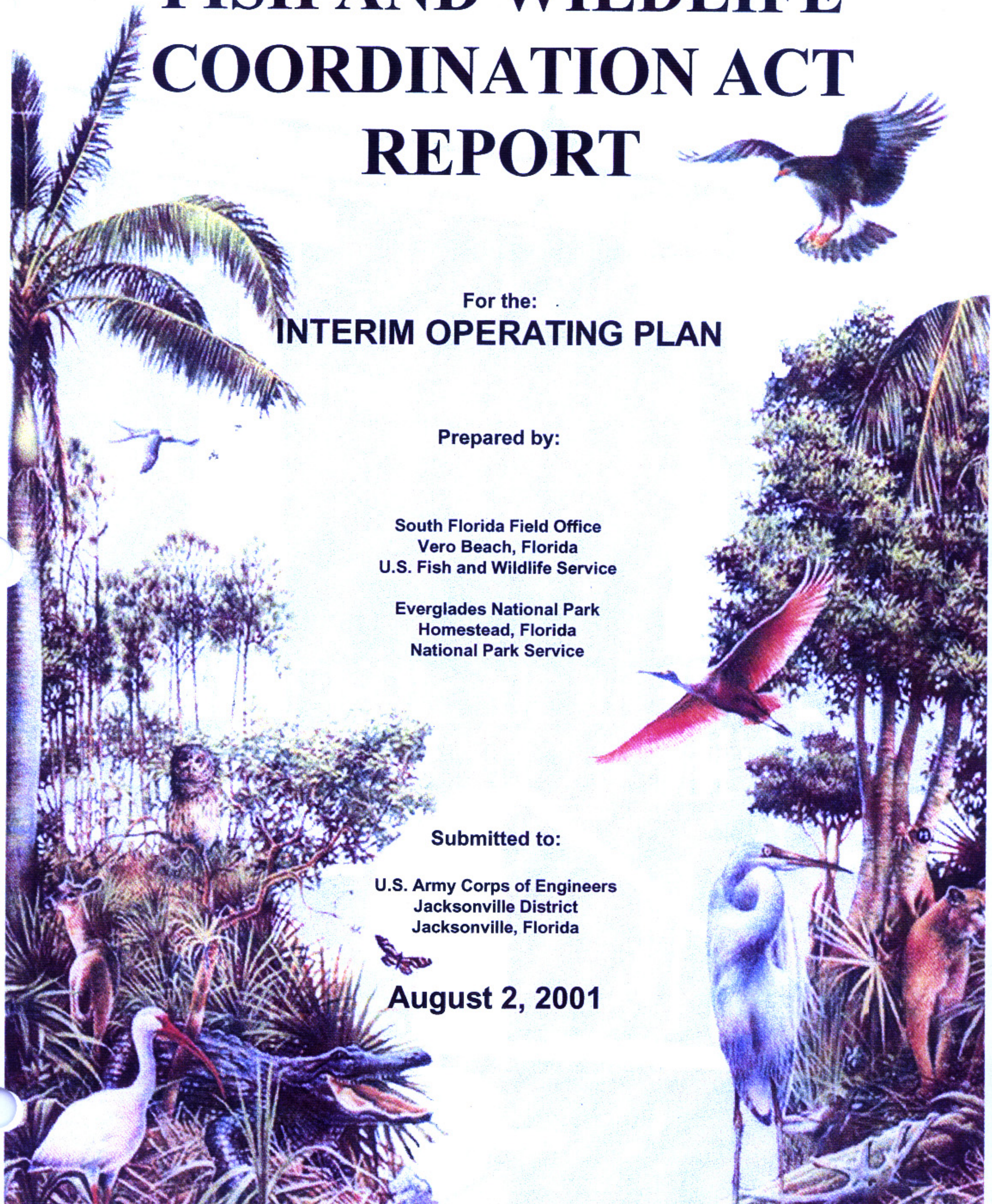
1. DOI will advise the Corps of any overflow problems or adverse impacts to the CSSS subpopulation F that may be occurring for the Corps to use in their decision regarding pumping reductions at S-332B.

2. Otherwise, stages in canal reaches must be within the specified operating ranges in place prior to the change to pre-storm or storm operations to resume normal mode.

Once these conditions are met, the normal mode, as defined by operational regime in place prior to the storm, may be resumed. Emergency use of certain water control structures, such as S-175 and S-332B, would cease.

This document may be modified depending on additional information, as it becomes available.

FISH AND WILDLIFE COORDINATION ACT REPORT



For the:

INTERIM OPERATING PLAN

Prepared by:

South Florida Field Office
Vero Beach, Florida
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Everglades National Park
Homestead, Florida
National Park Service

Submitted to:

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Jacksonville District
Jacksonville, Florida

August 2, 2001

Executive Summary

This Fish and Wildlife Coordination Act Report (CAR) was jointly prepared by the Fish and Wildlife Service (FWS) and National Park Service (NPS), Everglades National Park (ENP) to analyze and evaluate the current Interim Structural and Operational Plan (ISOP) and several alternatives for the Interim Operating Plan (IOP) presented in the Army Corps of Engineers (Corps) February, 2001, draft IOP Environmental Impact Statement (EIS). The primary purpose of the IOP is to provide for water management operations in South Florida that will comply with the Fish and Wildlife Service's (FWS) February 19, 1999, reasonable and prudent alternative (RPA) and incidental take statement requirements for the endangered Cape Sable seaside sparrow (CSSS) under the Endangered Species Act (ESA). The IOP will be in effect in until the Modified Water Deliveries Project is implemented in late 2003. We evaluated the IOP Alternatives according to a prioritized set of objectives:

First Priority: Meet ESA requirements for the CSSS.
Second Priority: Minimize impacts to other listed species.
Third Priority: Minimize impacts to other natural resources.

Prior to release of the draft IOP EIS, the FWS and Corps had worked out an agreement for water management operations affecting the CSSS's Western habitat (see **Figure 5.14** for a map showing CSSS habitat areas) that would provide the maximum protection to this area possible with the current water management system. Although the draft EIS presents six alternatives, only three of them include these agreed-upon operations **(Figure E.1)**. Additionally, the draft EIS included two phases for each alternative corresponding to operations before and after mitigation features for the 8.5 Square Mile Area **(Figure 1.1)** have been constructed. However, the Corps has since indicated that operations after the 8.5 Square Mile Area features have been built will be designed through a different process. Therefore, this CAR includes a complete analysis of only Phase I of those alternatives that include the agreed-upon operations, Alternatives 1, 5 and 6.

Our analysis of Alternatives 1, 5 and 6 included results of monitoring of nearly identical operations that have been implemented over the past year or so, the ISOP. These monitoring results, additional hydrologic analysis performed by ENP hydrologists, and biological analyses performed by FWS and ENP biologists, indicated that the Corps' hydrologic modeling of the ISOP and Alternatives 1, 5 and 6 had significant limitations and that serious unintended consequences to the CSSS, several of the CSSS habitat areas, and several other natural areas were likely to continue if any of these alternatives were implemented. These results are summarized graphically in **Figure E.2**. Accordingly, the FWS has determined that Alternatives 1, 5 and 6 are not likely to provide for water management operations in South Florida that will comply with the February 19, 1999, RPA and incidental take statement requirements for the CSSS.

Discussion of these results of our analyses with the Corps led to an agreement among the Corps, FWS, NPS and the South Florida Water Management District (SFWMD) to attempt to address our concerns through a conflict resolution process. These discussions were facilitated by the U.

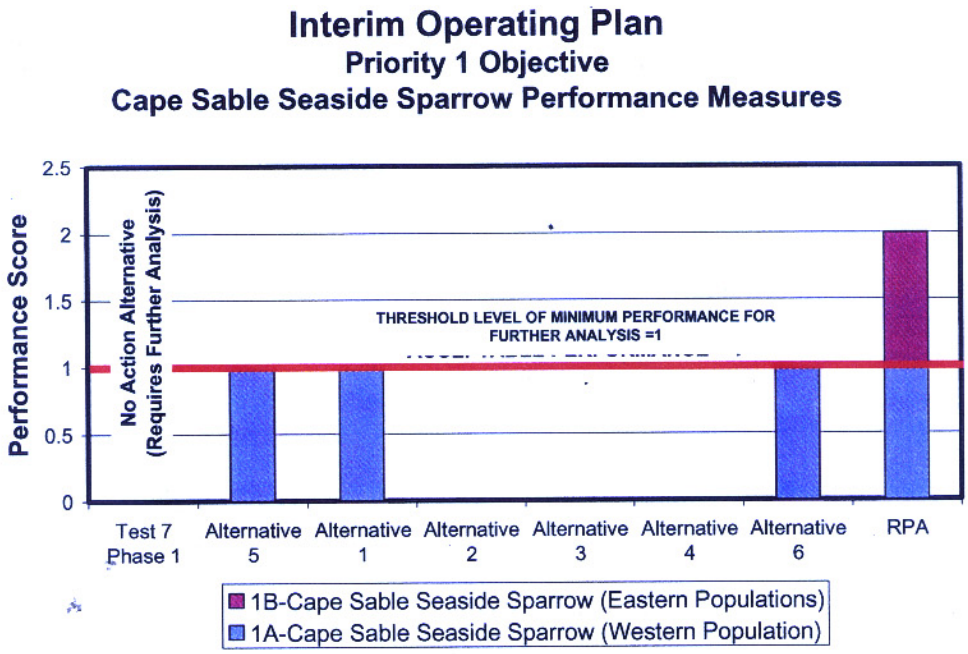

Figure E.1. Performance scores for IOP Priority 1 Objective, CSSS.

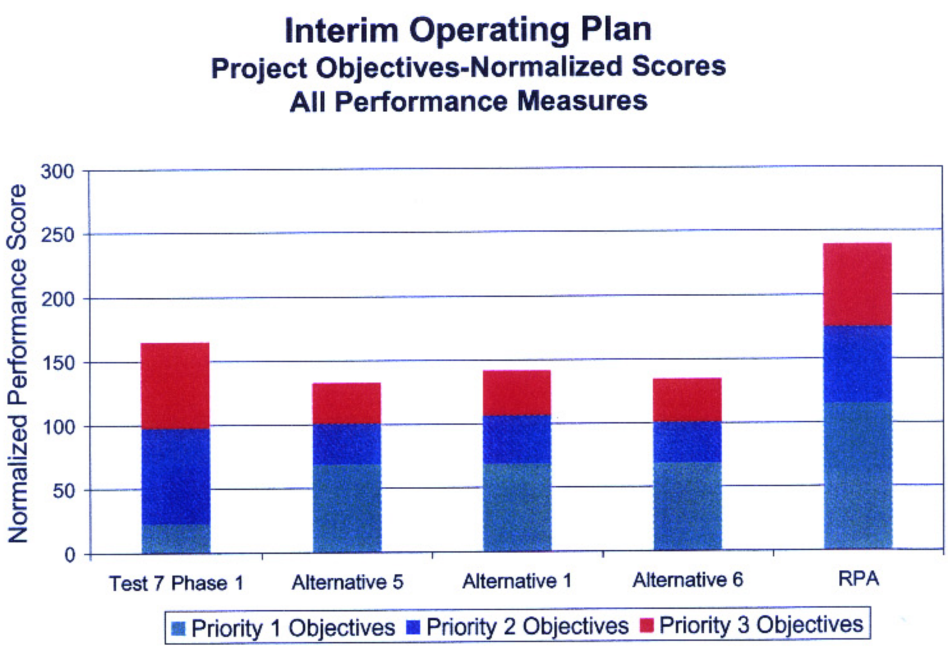

Figure E.2. Normalized scores for Priority 1, 2, and 3 IOP performance measures.

S. Institute for Environmental Conflict Resolution, which provided neutral facilitators to help guide our discussions towards consensus and document our agreements. This conflict resolution process was successful, culminating in agreement among the four parties on an adjusted IOP alternative, Alternative 7. However, final development of this agreement was accomplished just a few working days before the second draft IOP EIS had to be completed, leaving insufficient time for a full analysis of Alternative 6X in this CAR. Accordingly, our preliminary analysis of Alternative 7 has been provided as an addendum to this CAR. The best currently available scientific and commercial information indicates Alternative 7 is likely to comply with current ESA water management requirements for the CSSS, and minimize adverse effects to other listed species and other natural resources as compared to the draft IOP EIS Alternatives. Although the FWS and NPS continue to recommend the original RPA as the environmentally preferred alternative for the IOP, we find Alternative 7 acceptable and greatly appreciate the Corps and SFWMD's willingness to work out this agreement with us.

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Summary, Conclusions and Recommendations

List of Acronyms

American Ornithological Union	AOU
Biological Opinion	BO
Cape Sable seaside sparrow	CSSS
Central and Southern Florida Project	C&SF
Coordination Act Report	CAR
Council on Environmental Quality	CEQ
Department of the Interior	DOI
Endangered Species Act	ESA
Environmental Assessment	EA
Environmental Impact Statement	EIS
Everglades National Park	ENP
Executive Orders	EO
Finding of No Significant Impact	FONSI
Fish and Wildlife Coordination Act	FWCA
Florida Department of Environmental Protection	FDEP
Indicator Region	IR
Interim Operating Plan	IOP
Interim Structural and Operational Plan	ISOP
Lower East Coast	LEC
Modified Water Deliveries	MWD
Modified Consent Decree	MCD
Multi-Species Recovery Plan	MSRP
National Environmental Policy Act	NEPA
National Geodetic Vertical Datum	NGVD
National Park Service	NPS
Natural System Model	NSM
Northeast Shark Slough	NESS
Northwest Shark Slough	NWSS

List of Acronyms continued

Outstanding Florida Waters	OFW
Planning Aid Letter	PAL
Reasonable and Prudent Alternatives	RPA
Record Of Decision	ROD
Remedial Action Plan	RAP
South Dade Conveyance System	SDCS
South Florida Water Management District	SFWMD
South Florida Water Management Model	SFWMM
Stormwater Treatment Areas	STA
Systematic Reconnaissance Flight	SRF
U. S. Fish and Wildlife Service	FWS
U.S. Army Corps of Engineers	Corps
U.S. Environmental Protection Agency	EPA
Water Conservation Area	WCA

Chapter 1– Project Purpose, Scope, and Authority

1.1 Project Objectives

The project has three objectives, which are approached in order of priority. The highest priority is given to achieving compliance with the Endangered Species Act (ESA) by meeting hydrological targets for the Cape Sable seaside sparrow (*Ammodramus* (=*Ammospiza*) *maritimus mirabilis*) (CSSS) as established in the Reasonable and Prudent Alternatives (RPA) issued by the U. S. Fish and Wildlife Service (FWS). This will be accomplished by evaluating the hydrological outputs from the South Florida Water Management Model (SFWMM) as simulated for a selection of water management alternatives and other hydrologic analysis presented in Chapter 4. The outputs will then be compared with performance measures based on the nesting and habitat requirements of the CSSS in the six sub-populations.

An important but second-level priority is given to minimizing, in all operations which would be conducted to meet RPA requirements, adverse impacts to other species listed under the ESA. To the extent that alternatives for achieving RPA compliance are available, their differential effects upon other listed species will become a major consideration in recommending an alternative. Several endangered species potentially could be affected by water management actions conducted on behalf of the CSSS. These include the snail kite (*Rostrhamus sociabilis plumbeus*), wood stork (*Mycteria americana*), American crocodile (*Crocodylus acutus*), and West Indian Manatee (*Trichechus manatus*). Hydrological model output will be evaluated in terms of performance measures that relate to key aspects of the species' life histories.

As a third priority, it is important to evaluate to what extent actions taken in meeting the first two priorities (as simulated) affect other ecological resources of the area. Particular attention will be given to such fundamental ecosystem aspects as the water levels and depths needed to support aquatic plant communities in Shark Slough, the adequacy of flows into Florida Bay to establish healthful salinity regimes, and the minimum groundwater depths found in the marl prairies under varying rainfall conditions.

1.2 Report Objectives

The FWS and National Park Service (NPS) have prepared this Fish and Wildlife Coordination Act Report (CAR) for the U.S. Army Corps of Engineers' (Corps) Environmental Impact Statement (EIS) for the Interim Operational Plan (IOP), Broward, Collier, Miami-Dade and Monroe counties, Florida. The EIS analyzes and evaluates several alternatives intended to implement hydrologic requirements of the RPA outlined in the FWS' February 19, 1999, Biological Opinion (BO) on the Program of Experimental Water Deliveries to Everglades National Park (Experimental Program) and the endangered CSSS. The IOP is intended to meet requirements for the year 2001 and until implementation of the Modified Water Deliveries (MWD) Project to Everglades National Park (ENP). A similar project, the Interim Structural and Operational Plan (ISOP), is being implemented currently and is intended to meet RPA hydrologic requirements prior to IOP implementation. IOP alternatives analyzed in the EIS also include features designed to maintain or improve flood control for urban and agricultural areas and to minimize and/or re-distribute adverse impacts to natural resources resulting from these features and RPA compliance features. The South Florida Water Management District (SFWMD) is the local sponsor for this project. This CAR is provided in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended: 16 U.S.C. 661 et seq.) (FWCA) and constitutes the Secretary of the Interior's Report to Congress on the IOP in accordance with Section 2(b) of the FWCA. We understand that the Florida Fish and Wildlife Conservation Commission will prepare a separate CAR reflecting their views and recommendations on this project.

This CAR provides the Department of the Interior's (DOI) analyses and recommendations pertaining to the alternatives proposed for implementation of RPA requirements for the year 2001 and until MWD implementation (As the two Department of the Interior agencies involved with this document, NPS and FWS are collectively referred to as DOI in this document).

1.3 Report Content

Chapter 1 describes the purpose, scope, and authority for the IOP. This chapter also details the objectives of the project and the performance measures that were used in the evaluation sections of the report, and provides a history of recent water management programs and associated compliance with natural resources law. The DOI completed an analysis of the alternatives based on the performance measures under the legislative authorities discussed.

Chapter 2 and 3 describe the project's location and the natural resources of particular concern to the DOI. Chapter 2 and 3 contain an explanation of the without project, existing conditions and future without project conditions. Chapter 4 provides an explanation of the alternatives being considered for implementation, and hydrologic analysis of actual ISOP implementation. Chapter 4 also anaylses potential sources of error in SFWMM modeling of IOP and ISOP alternatives/

Chapter 5 and 6 include all biological evaluations conducted by DOI. These evaluations focus on endangered species and other biological evaluations associated with each of the proposed alternatives. These analyses as much as possible used the performance measures specified in Chapter 1. In some areas, uncertainty in the SFWMM results necessitated use of analysis in Chapter 4 to inform biological evaluations.

Summary, Conclusions and Recommendations includes DOI's position and recommendations. DOI's position is based on the complete set of performance measures, including most of the Corps' performance measures, and Chapter 4 analysis, using the legislative authorities provided DOI as outlined in this Chapter.

1.4 Background

Water management problems associated with the southern Everglades most probably date back to the early 1920's, when the completion of the arterial canal system between Lake Okeechobee and the coast were completed. These features of the Central and Southern Florida (C&SF) Project allowed for the diversion of considerable quantities of water to tide away from the more historical drainage through the Everglades drainage basin. These water control works were further augmented through the completion of the Eastern Protective Levee System in the 1950's and the closure of the Water Conservation Areas (WCA) north of ENP in the 1960's.

Coupled with the closure of these areas was the reduction in water releases to ENP. For many months during the years 1961 through 1965 no water was discharged from the WCAs to ENP **(Figure 1.1)**. The capability to control water releases into ENP provided the first direct evidence of the ecological consequences of water management for the combined purposes of water supply, flood control, as well as environmental protection. In an effort to hold water within the WCAs for purposes of water supply during this low rainfall period, the lack of water releases to ENP caused widespread fires within the region and underscored the need for some assurance of water supply to ENP from the system.

1.4.1 History and Legislative Authority of Water Deliveries to Everglades National Park

1.4.1.1 Pre-Experimental Program Water Deliveries

In recognition of the water requirements of the Everglades, Congress passed Public Law 91-282 authorizing the development of a minimum water delivery program to guarantee adequate surface water inflows from the upstream WCAs. In June 1970, the Minimum Delivery System for ENP was mandated, requiring a minimum allocation of 315,000 acre-feet to be delivered to the park, according to a fixed monthly schedule for each of the three main drainage basins (Shark Slough, Taylor Slough, and the Eastern Panhandle). The largest of these basins, Shark Slough, had an annual minimum allocation of 260,000 acre-feet to be delivered through four structures (S-12 A, B, C, and D) located between the L-67 extension levee/canal and Forty Mile Bend **(see Figure 1.1)**. This structural configuration limited the release to just the western portion of the drainage basin and purposefully restricted inflows to Northeast Shark Slough (NESS) corresponding to the park boundary existing during this time. While the minimum water delivery schedule addressed the dry year concerns of drought and the potential for devastating fires, the schedule failed to address water releases associated with wet periods. The latter concern became very evident in the wet years of the early 1980's when large water releases were made to western Shark Slough causing widespread alligator nest flooding (Kushlan and Jacobsen 1990) as well as other observations of ecological damage. The high rainfall during this period, coupled with the extremely high water releases from WCA-3A, prompted the park to request emergency relief from the SFWMD. The relief requested was in the form of a seven point plan consisting of the following major elements:

- Re-establishment of flows along the entire historic Shark Slough cross-sectional flowway, including NESS. This included the re-introduction of water into WCA-3B.
- Modification of the structural features controlling water release to the park, including the installation of plugs in the L-67 extension canal and L-28 canal to encourage a more natural distribution of water flow within the Shark Slough and Big Cypress drainage basins.
- Implementation of a water delivery system for the Shark Slough basin more closely associ-

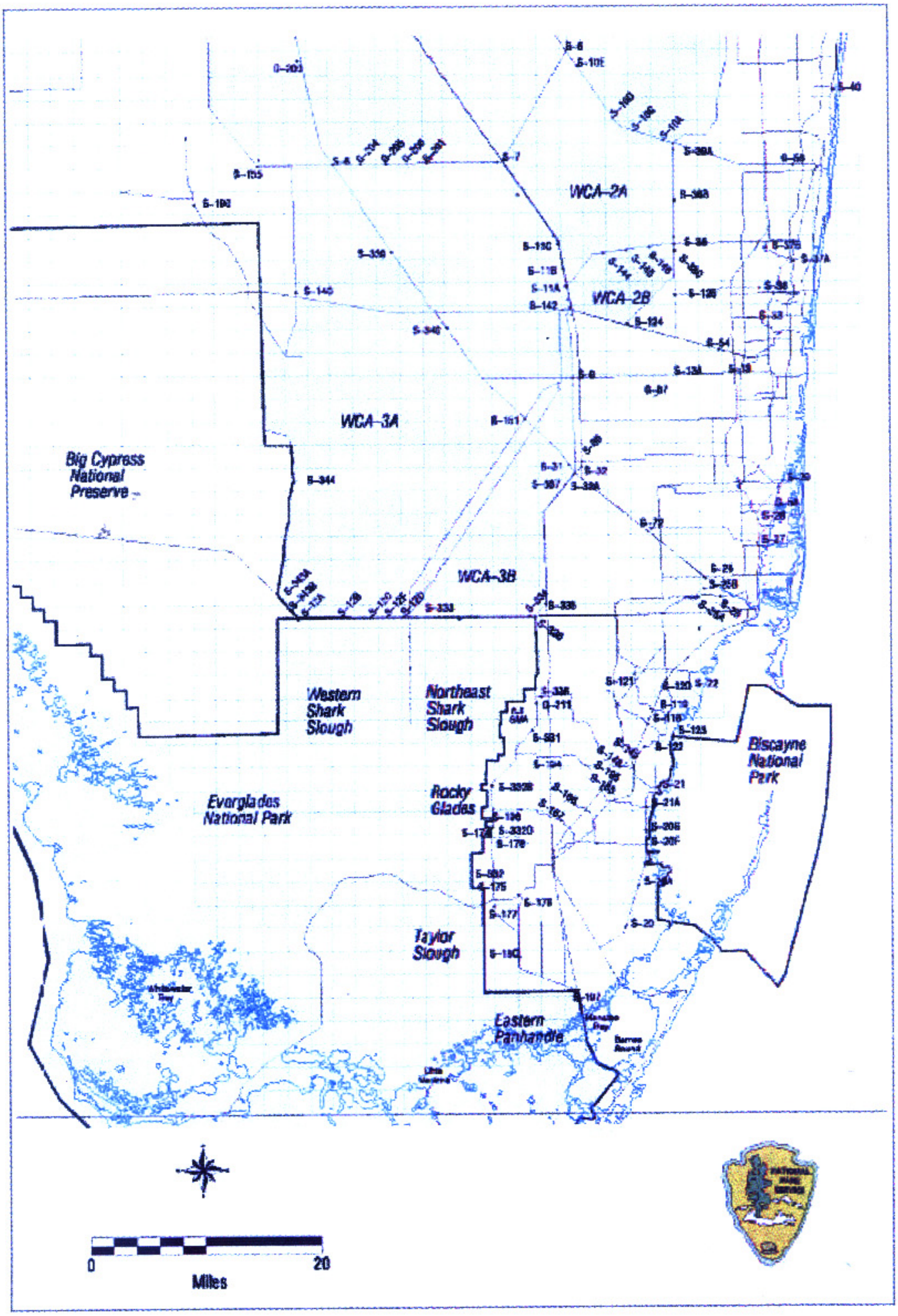

Figure 1.1 General locations and features of the study area.

ated with natural climatological events rather than water management needs.

In response to the request for relief from the park, the SFWMD and the Corps in March 1983 approved the temporary use of S-333 to discharge water from WCA-3A into NESS to mitigate for the large water releases to western portion of the basin. Water releases through S-333 continued until mid-June 1983 when concerns were raised over the increased potential for flooding in the East Everglades, particularly the 8.5 Square Mile Area. To mitigate for the increased risk of flooding to this area, the S-331 pump station in the L-31N canal was operated for flood control instead of its original intended purpose of water supply as a component of the South Dade Conveyance System (SDCS). Coincident with these operations, the S-12 A through D structures were allowed to remain open full in order to assess the impacts of a Flow-Through Plan for water deliveries to Shark Slough. This plan allowed for the uncontrolled releases of water from WCA-3A into the western Shark Slough region of the park as a mechanism to eliminate the large regulatory releases associated with the minimum delivery schedule. During this time, other features of the Seven Point Plan were implemented, including the construction of S-343 A&B and S-344 in the L-28 canal and levee and S-346 and S-347 in the L-67 extension canal. Implemented concurrently to the Flow-Through experiment and these structural modifications were two tests utilizing S-333 for discharging water into NESS from WCA-3A. Referred to as the 30-day and 90-day tests, these two experiments tested the ability to move water into NESS in a manner consistent with the requests of the park while also preserving the water supply and flood control objectives of the C&SF Project. While the Flow-Through Plan accomplished the objective of eliminating the large erratic releases of water to ENP, the water supply project purposes of the C&SF Project were compromised and the plan was discontinued in May 1985. However, operations associated with these tests provided the framework for what would ultimately constitute the Experimental Program.

1.4.1.2 The ENP Experimental Water Deliveries Program

In November 1983, Congress passed Public Law 98-181 authorizing a Experimental Water Deliveries Program. This law provided the authority to deviate from the minimum delivery schedule through the use of iterative field tests for the explicit purpose of developing an optimum water delivery schedule for ENP. The authority provided to the Corps to modify the ENP delivery schedule through this Act also required that concurrence be provided by the NPS and the SFWMD. In response to this authority, the Corps completed an Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) in June 1985 which specified the conditions for the first official iteration of the Experimental Program. Using the EA authority, the Corps, the SFWMD, and NPS entered into the first (Iteration 1) in a series of tests **(Table 1.1)** and associated requisite concurrency agreements for conducting the Experimental Program.

Iteration 1, commonly referred to as the Rainfall Plan, included operational criteria that lowered the water levels in the L-31N canal on the eastside of ENP as well as the following components designed to benefit the resources of the park while minimizing the impacts to the developed portion of the East Everglades:

1. Implementation of water delivery plan containing a rainfall discharge component for water

Table 1.1 Timelines, authorities and National Environmental Policy Act compliance for water deliveries to Everglades National Park.

Delivery Period	Dates	Legislative Authority	NEPA Compliance
Minimum Delivery	June 1970- May 1983	P.L. 91-282 (1969)	C&SF Project NEPA Compliance
Flow-Through	June 1983- May 1985	P.L. 91-282 (1969)	C&SF Project NEPA Compliance
30 Day Test	April 19, 1984- May 18, 1984	Unknown	Unknown
60 Day Test	August 1, 1984- November 30, 1984	Unknown	Unknown
Iteration 1 (Rainfall Plan) Experimental Program	June 1985- June 1987	P.L. 98-181 (1984) Created Experimental Program	EA and FONSI June 7, 1985
Iteration 2 Experimental Program	June 1985- June 1988	P.L. 99-190 (1985) Extended Program through January 1989	Continuation of Iteration 1
Iteration 3 Experimental Program	July 1988- January 1989	P.L. 99-190 (1985)	Continuation of Iteration 1
Iteration 4 Experimental Program	January 1989- January 1992	P.L. 100-676 (1988) Extended Program through January 1992	Continuation of Iteration 1
Iteration 5 Experimental Program	January 1992- June 1993	P.L. 102-104 (1991)Extended Program until MWD Project complete	Continuation of Iteration 1
Iteration 6 (Taylor Slough Iteration) Experimental Program	January 1993- July 1995	P.L. 102-104 (1991)	EA and FONSI: June 21, 1993
Iteration 6 Extended Experimental Program	July 1995- October 1995	P.L. 102-104 (1991)	EA and FONSI: June 30, 1995
Iteration 7 Experimental Program	October 1995- March 1999	P.L. 102-104 (1991)	EA and FONSI: October 30, 1995

releases to Shark Slough, including the releases to NESS. The intent of this delivery component was to base a portion of the discharges to the park on more natural climatological events rather than man-induced regulatory schedules.

2. The strict regulation schedule previously used for the management of WCA-3A was replaced with a set of five operational zones for the quantification of the regulatory discharge component of the plan. These zones allowed for better transitioning of the regulatory discharge component between dry and wet periods.
3. The use of a trigger water level in the developed portion of the East Everglades above which water releases through S-333 into NESS would cease. The purpose of this override was to satisfy legal agreements made by the SFWMD with landowners in the area concerned about the potential increase in flood risk associated with the program.

4. The implementation of an extensive hydrological and ecological monitoring program with the purpose of providing needed information for future iterations of the experimental program.

Iteration 1 of the Experimental Program was conducted for a period of two years, from June 1985 through May 1987. Iterations 2 through 5 of the Experimental Program were essentially extensions of the conditions associated with Iteration 1, under the prevailing legislative authority in place at the time of the tests. Results of these early tests were thoroughly documented (Neidraurer and Cooper 1989; Van Lent et al. 1993) and included the following highlights:

1. The regulatory component of the Rainfall Plan of water deliveries exceeded the rainfall component by a factor of 2 to 1 during the wet season.
2. The trigger water level in controlling the releases of water through S-333 into NESS was not always necessary to protect the developed portions of the East Everglades.
3. The limitations on the use of S-333 and the lowering of the L-31N canal stage resulted in lower water levels than the levels present prior to the initiation of the experimental program.

Based on the results attained from the first five iterations of the Experimental Program, Test 6 or the Taylor Slough Iteration was conducted to expand the program into other regions of ENP. In the EA and associated FONSI for this iteration, completed in June 1993, the Corps stated the objectives were to "evaluate methods to restore more natural hydroperiod and ecosystems within ENP including NESS and Taylor Slough, as well as, reduce large, freshwater discharges through S-197 into Manatee Bay and Barnes Sound". In general, this test included all of the operational components of the first six iterations, with the addition of auxiliary pumps at pump station S-332 in order to increase the discharge capacity into Taylor Slough from 165 cfs to 500 cfs. As stated in NPS technical reports (National Park Service 1995; Van Lent et al. 1999), the primary purpose of Iteration 6 was to maintain optimum wet season water levels in the L-31N, L-31W, and C-111 canals. ENP maintained that this approach would allow for more storage of wet season rainfall in the upstream wetlands, thereby reducing excessive groundwater seepage losses, attenuate the rapid fluctuations in flows associated with flood control operations, and delay the release of wet season runoff, producing more persistent flows into the dry season. While some benefits to ENP of this test were realized due to the increase in water levels within Taylor Slough due to flow augmentation, Iteration 6 operations essentially resulted in the continuation of the practice of lower water levels in the L-31N canal allowing for removal of water from one area of the park (the Rocky Glades) in order to supply water to another part (Taylor Slough). Iteration 6 "extended" allowed for the continuation of Iteration 6 until completion of the needed National Environmental Policy Act (NEPA) analysis associated with the proposed components of Iteration 7.

Iteration 7 was the final iteration of the Experimental Program. This test attempted to remedy some of the problems identified in previous iterations, particularly Iteration 6. The purpose of Iteration 7 (Corps 1997) was to capitalize on the acquisition of the Frog Pond adjacent to ENP for the implementation of an improved water delivery plan for Taylor Slough. Acquisition of these lands allowed for increased operational levels within the L-31W canal based on stage targets predicted from an analysis of historical rainfall in the Taylor Slough basin. Additional operational flexibility was also thought to result from construction of pump station S-332D, and the increase in the operational levels of the L-31N canal. It should be noted that the increases in stage in the L-31N canal associated with Iteration 7 were designed to provide benefits to the park but were still well below the authorized levels. The operational levels in the L-31N are of paramount importance to the preservation of the ecological resources of the park. For this reason, the subject of the operational rules associated with water deliveries to ENP, in the context of NEPA compliance, is discussed further in Section 1.4.2.

The hydrologic impacts of Iteration 7, Year 1 of the Experimental Program are well documented (Test 7 Year 1 Report). The overall impact of the iteration though are summarized in Van Lent et al., 1999. This report made the following observations regarding the Experimental Program.

The primary benefits of the Experimental Program:

- Decreased "spikiness" of the S-12 discharges related to the additional zones in the WCA-3A regulation schedule
- Improved Taylor Slough hydrologic regimes related to L-31W operations
- Improved hydroperiods in NESS

The primary drawbacks of the Experimental Program:

- Annual average flow volumes into ENP and toward the Shark Slough estuaries decrease relative to the Minimum Schedule
- The decrease in flows into Shark Slough results in drier conditions in western Shark Slough during average and below average periods
- Shorter hydroperiods and lower water levels west of L-31N (NESS) and WCA-3A, the Rocky Glades and northern Taylor Slough

The report further concluded that the Experimental Program had no effect on the following:

- Flow volume, timing, and distribution across Tamiami Trail (S-12 and S-333 structures) during wet periods
- Water levels for western Shark Slough and NESS during wet periods
- Inflows into NESS during the wettest 25% of the years due to management induced curtailment

1.4.1.3 Post-Experimental Program Water Deliveries

Public Law 102-104 passed in 1991 provided the authority for the continuation of the Experimental Program until the MWD Project, authorized under a separate authority (P.L. 101-229), was completed. During the Experimental Program period from 1985 to present, the FWS has consulted with the Corps on the implementation of each phase of the program. One of the primary reasons for the consultation was concern for the endangered CSSS. Based on census data provided by NPS, increasing concern was expressed by the FWS on the impacts of the Experimental Program on the continued existence of the CSSS and its designated critical habitat. The population census data from 1995 and other available scientific information led the FWS to conclude in its BO of October 27, 1995 that Test Iteration 7 was likely to jeopardize the continued existence of the CSSS. The BO also instructed the Corps to develop a Remedial Action Plan (RAP) as part of the reasonable and prudent alternative to avoid jeopardy. Due to disagreements on the content of the RAP, the plan floundered for several years until the FWS, alarmed by the 1996 and 1997 CSSS census data showing continued population declines, asked the Corps to reinitiate consultation in November 1997. The Final BO resulting from this reinitiated consultation was delivered to the Corps on February 19, 1999. The 1999 BO affirmed the previous BO and concluded that Iteration 7 of the Experimental Program was likely to jeopardize the continued existence of the CSSS and to destroy and adversely modify the CSSS's designated critical habitat. In response to the 1999 BO, the Corps informed the FWS of their intention to immediately terminate the Experimental Program and implement a plan of "emergency actions", on behalf of the CSSS. Although this decision resulted in much controversy, continued discussions with NPS and FWS resulted in the Corps' development of the ISOP. This plan consisted of alternative C&SF Project operations to Iteration 7 for the purpose of complying with the FWS hydrologic requirements as detailed in the reasonable and prudent alternative of the 1999 BO through 2000. The Corps also initiated the NEPA process for the development of IOP operating criteria to meet the BO requirements from 2001 until the MWD Project has been completed in 2003. The later process is the subject of this CAR. Although the Corps attempted to return to Iteration 7 operations following the 1999 CSSS breeding season, the SFWMD refused to concur, effectively ending the Experimental Program.

1.4.2 Experimental Water Deliveries and NEPA Compliance

It is the opinion of the Corps that compliance with the NEPA for the Experimental Program was met through the completion of four EAs and the associated FONSI for each assessment. Each of these documents is referenced in the preceding sections and also summarized in **Table 1.1**. However, the DOI has identified several procedural issues related to compliance with NEPA. These issues pertain to (1) compliance for Experimental Water Deliveries conducted prior to Iteration 1, (2) continuity of the Without Project Condition (Base condition) throughout and after the Experimental Program, and (3) use of interim operational authority by the Corps upon termination of the Experimental Program in 1999. Each of these issues will be discussed further below.

1.4.2.1 Experimental Water Deliveries Prior to Iteration 1

Three water delivery experiments were conducted prior to the completion of the first EA for the Experimental Program in 1985. These were the Flow-Through, 30-Day and 90-Day Tests. The tests were initiated as early as June 1983 through action taken by the local sponsor of the C&SF Project, the SFWMD, based on a request of NPS to modify deliveries of water to ENP. Since the request by the park was made of the local sponsor, it is presumed that these tests were conducted under the scope of authority provided to the Corps and the SFWMD for the overall operation of the C&SF Project. If this assumption is incorrect, questions regarding the authority for these tests arise. First, the Flow-Through Test involved modifications to the operations of the S-12 A-

D structures, C&SF Project features under the operational control of the Corps, not the SFWMD. Therefore, any action to modify the operation of these structures becomes a Federal action and subject to the provisions of NEPA. Since the request by NPS for modifications to the delivery schedule was based on the impacts to the environment, one would assume that proposed modifications to alleviate these impacts would be subject to NEPA. Additionally, one could also assume that if any modifications to the operations would be significant enough to result in major benefits to the ecology of the park, these modifications should be addressed in an EIS rather than an EA/FONSI. Based on information provided to the DOI, none of these actions were considered through an EA or an EIS under NEPA.

1.4.2.2 Without Project Conditions

Throughout the seven iterations of the Experimental Program, the Corps used a consistent set of operating criteria to define the without project condition or no-action alternative. This "base" condition has been commonly referred to as Base 83 and was used as the basis of analyzing and ultimately selecting alternatives for implementation. This base condition represented the prevailing operating rules for all pertinent structures at the inception of the Experimental Program in 1983. These conditions also firmly established the base level of flood protection provided by the SDCS. While some confusion may have existed on the actual rules associated with particular structures within the context of the Base 83, the Corps never deviated from this Base condition in any of the NEPA documents associated with the water delivery tests. Furthermore, the Corps stated in the Test 7 Iteration Final EA and FONSI that should the Experimental Program be discontinued, the operating rules would revert back to the no-action or Base 83 operating rules. Specifically, the following changes would result should the Experimental Program be terminated (Corps 1995):

1. Discontinue the Experimental Program to NESS and return to the Minimum Delivery schedule prescribed in P.L. 91-282.
2. Discontinue all supplemental water deliveries to Taylor Slough through S-332 and return to the Minimum Water delivery schedule prescribed by P.L. 91-282.
3. Canal stages would be set at optimum levels as described in Part V, Supplement 52 of the GDM on the Everglades National Park-South Dade Conveyance System. G-211 would no longer be used.

Since these are the criteria established under NEPA, it is the opinion of the DOI that adopting any other set of conditions, such as the Base 95 operating criteria used for the IOP NEPA process, is inappropriate. The DOI strongly encourages the Corps to maintain the continuity of base conditions throughout the series of NEPA documents associated with water deliveries to ENP. While it may be within the purview of the Corps to modify the base condition, the change has never been thoroughly analyzed for the impacts on ENP. This is contrary to the purpose of the Experimental Program and is also inconsistent with NEPA.

The basis for the termination of the Experimental Program on March 9, 1999 by the Corps was to implement a series of emergency actions to improve the likelihood that water levels in the western habitat of the CSSS would be suitable for breeding. Theoretically, termination of the

Experimental Program should have resulted in reverting back to operating criteria specified in Section 1.4.1.1 , except for those criteria specifically changed to enhance the chances of breeding in the western CSSS habitat. At a minimum, the conditions should have remained the same as the Iteration 7 Phase 1 criteria to be consistent with the existing NEPA documentation. However, the operating criteria instituted during the ISOP allowed for the lowering of water levels in the L-31N canal, providing the potential for a higher level of flood protection without assessing the impacts of these lowered water levels on the resources within ENP. Since the Corps was acting under emergency authority for the protection of the CSSS, all emergency actions should have been justified solely on the benefits provided the CSSS. Any enhancements of flood protection under this authority could have exceeded the limits allowed by the alternative arrangements granted by the Council on Environmental Quality (CEQ) for NEPA compliance under the emergency authority. Should the Corps maintain that these operations were done to offset the large volumes of water being transferred to the L-31N due to the other operational criteria associated with the ISOP, the Corps must also assure that the lowering of canal stage will be a temporary action. However, the Corps has now adopted these criteria as the base condition (existing condition) to be assessed in the IOP EIS. The Department of the Interior has long maintained that the only legitimate base condition for all alternatives to be compared is the Base 83 condition, as specified in all NEPA documents prepared to date. Should the Corps wish to adopt a new set of operating criteria to enhance flood protection, it should be done using an appropriate authority, other than the Experimental Program or emergency authority, and should also be thoroughly documented as required by NEPA.

1.4.3 Purpose and Requirements of the Endangered Species Act

In enacting the ESA of 1973 and subsequent amendments, the President and Congress declared in Section 2 of the Act:

> "The purposes of this Act are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth [in the Act]."

> "It is ... the policy of Congress that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act."

> "It is ... the policy of Congress that Federal agencies shall cooperate with State and local agencies to resolve water management issues in concert with conservation of endangered species."

In section 7 of the Act, Congress and the President instructed:

> "All...Federal agencies shall, in consultation with and with the assistance of the Secretary [of Interior], utilize their authorities in furtherance of the purposes of the Act

by carrying out programs for the conservation of endangered species and threatened species...."

"Each Federal agency shall, in consultation with and with the assistance of the Secretary [of Interior], insure that any action authorized, funded, or carried out by such agency... is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined ... to be critical..."

1.4.4 History of Section 7 Consultation Process

The following chronology provides a history of the Corps' ESA compliance efforts for the Experimental Program leading up to the current RPA requirements:

In November 1983, as a result of adverse environmental effects within ENP related to high rainfall and water management practices in south Florida, Congress enacted legislation that authorized the Experimental Program, allowing the Corps, with the concurrence of the NPS and SFWMD, to deviate from the existing minimum water delivery schedule established for ENP by Congress in 1970. The Experimental Program was implemented through a series of test iterations. On June 5, 1985, the FWS concurred with the Corps determination that test Iterations 1-5 would have no effect on listed species. At this time, only 1981 survey results for the CSSS were available and these estimated a relatively large population of 6,665 birds.

The next two CSSS surveys were conducted in 1992 and 1993. The 1992 survey showed large percentage declines in numbers for sub-populations C, D and F, but estimated 6,574 birds overall, so the FWS was not particularly concerned about CSSS status at that time. The 1993 survey estimated only 3,312 birds, with precipitous declines particularly in the sub-population A habitat and no birds detected in sub-populations C and F. However, Hurricane Andrew had passed directly over these CSSS habitats between the two surveys, so CSSS biologists speculated that the hurricane may have caused the declines in CSSS numbers and that numbers should rebound over the next few years. Based on this available information, the FWS issued a BO on Test 6 on June 3, 1994, concluding that Test 6 was not likely to jeopardize the CSSS. The 1994 survey results were not yet available when this opinion was issued and the 1994 survey effort had been incomplete due to logistical problems, so when the 1994 survey results came in showing continued drastic declines, CSSS biologists were not able to rule out the incomplete survey effort as the reason for the smaller estimated numbers.

In a letter dated March 2, 1995, the Corps requested informal consultation and sought concurrence with their determination of effects to listed species from implementation of proposed Test 7 of the Experimental Program. The Corps evaluation concluded that implementation of the Test 7 proposal would have "no effect" on federally listed species, including the Cape Sable seaside sparrow, because the 1994 CSSS survey had indicated that the species was no longer present in Taylor Slough.

The 1995 survey results became available during consultation on Test Iteration 7. These results were complete and showed that declines had continued and that recovery expected after Hurricane Andrew had not occurred, implicating water management as the reason for declines.

In a letter dated September 22, 1995, the FWS responded to the Corps Preliminary EA and FONSI for Test Iteration 7 and accompanying determination that implementation of their preferred alternative "may effect" designated critical habitat for the CSSS. The FWS concluded that Test Iteration 7 was not likely to adversely affect the Florida panther, American crocodile, snail kite and eastern indigo snake, but that implementation was likely to adversely affect the CSSS, its designated critical habitat, and the wood stork.

On October 27, 1995, the FWS issued its BO that concluded that implementation of Test 7 was likely to jeopardize the continued existence of the CSSS, but would not adversely modify its critical habitat. In addition, the BO concluded that implementation of Test Iteration 7 was not likely to jeopardize the continued existence of the wood stork. As part of a reasonable and prudent alternative to avoid jeopardy to the CSSS, the FWS instructed the Corps to develop a Remedial Action Plan (RAP) for protection of the CSSS.

On November 14, 1995 the Corps wrote to FWS and "agree [s] to all the reasonable and prudent alternatives listed in the BO to avoid jeopardizing the continued existence of the . .. CSSS." However, the Corps qualifies its cooperation by requiring that FWS take the lead in coordinating the RAP described above. Disagreements over the RAP continue through the next two years.

Due to additional CSSS survey results showing increasing declines in CSSS numbers and other new information, the FWS asked the Corps to reinitiate consultation on the Experimental Program (Test Iteration 7), and two interrelated projects, the C-111 Project, and Modified Waters Deliveries Project in an October 17, 1997, letter. The Corps agreed in a letter dated November 4, 1997.

Notwithstanding reinitiation, work on the remedial action plan required by the 1995 RPA proceeded. The Corps sent a letter to the FWS on December 9, 1997, stating that it deleted from the FWS Draft RAP water management actions that the FWS believed were essential to avoid jeopardy to the CSSS. On January 15, 1998, the FWS finalized the RAP including the essential water management actions. On February 2, 1998, the Corps responded by finalizing its version of the RAP without the disputed water management actions.

Drafts of the new BO were provided to the Corps on July 21, 1998, and January 4, 1999. The Corps and other interested parties provided comments on both drafts. In response to these comments, the FWS significantly revised the BO, providing a more flexible RPA that allows the Corps to formulate alternative means to provide required hydrological conditions in CSSS habitats. The Final BO was delivered to the Corps on February 19, 1999, and included an RPA outlining hydrologic targets phased in over the 1999-2003 period as well as fire and vegetation management actions.

On September 13, 1999, the Corps wrote to the FWS conditionally accepting portions of the RPA. Further discussions led to the Corps' development of the December 14, 1999, ISOP, which was intended to meet hydrologic RPA requirements in 2000. The IOP is intended to meet RPA requirements through the 2001-2003 period.

1.4.5 Corps of Engineers Responsibilities for Alternatives Design and Selection

1.4.5.1 Endangered Species Act

As the Federal action agency for operation of and modifications to the C&SF Project, the Corps is responsible for the project's compliance with the ESA. As described above, this includes the requirement that the Corps ensure that its actions (or those of its' local sponsor for the project, the SFWMD) are not likely to jeopardize the continued existence of any Federally listed threatened or endangered species. Because the FWS has determined that Test Iteration 7 of the Experimental Program and similar operations are likely to jeopardize the endangered CSSS, the Corps must modify its operation of the C&SF project to avoid causing further jeopardy conditions for the CSSS. The FWS has provided targets for conditions in CSSS habitats that would avoid further jeopardy in the form of an RPA. The Corps is responsible for designing and implementing project operations and/or structural modifications that will provide RPA conditions in CSSS habitats.

A secondary ESA requirement pertinent to the ISOP and IOP is minimization of adverse effects to any other threatened or endangered species that would be affected by the project. This means that the Corps must explore, develop and analyze alternative ways to meet RPA targets that would minimize adverse effects to other listed species. When the Corps has a choice between two or more alternatives that would meet RPA targets, one of which would cause lesser adverse effects to other listed species than the others, the Corps should implement the alternative causing lesser adverse effects.

1.4.5.2 National Environmental Policy Act

Before the Corps can implement any proposed modifications to the C&SF Project, those modifications must be evaluated and disclosed under the NEPA of 1969 (42 U.S.C. 4321 et seq.). Due to its responsibilities for designing and constructing modifications to the C&SF Project and for ensuring that the project meets ESA requirements, the Corps has assumed the lead agency's role for the analysis of proposed alternatives for meeting RPA targets under NEPA. In the role as lead agency, the Corps determined that proposed alternatives potentially would have significant effects on the human environment and the NEPA analysis would have to be documented in an

EIS.

As the lead agency, the Corps has the ultimate responsibility for the content of the EIS. However, the EIS is supposed to use the environmental analysis and recommendations of cooperating agencies with jurisdiction by law or special expertise to the maximum extent possible, consistent with the Corps' own responsibilities as lead agency (Section 1501.6(a)(2)). If the lead agency leaves out a significant issue or ignores the advice and expertise of a cooperating agency, the EIS may be found later to be inadequate (CEQ 1981). This CAR contains the results of the FWS and NPS's primary environmental analyses and recommendations regarding hydrological and ecological effects of the alternatives on the CSSS and other fish and wildlife resources in the study area, and provides the FWS' recommendations on maximizing the chances that the IOP will meet ESA requirements.

Upon completion of this NEPA analysis, the Corps will issue a Record Of Decision (ROD) after full consideration of all viewpoints. The ROD will identify the alternative selected by the Corps for implementation.

1.4.6 Fish and Wildlife Service Responsibilities for Endangered Species Act Determinations

The ESA assigns responsibility to the Secretary of the Interior for providing advice and recommendations to Federal action agencies on how they may design and/or modify projects to meet ESA requirements to avoid jeopardy and minimize adverse effects to listed species occurring primarily on land or in fresh water. The Secretary of the Interior has in turn delegated this authority to the FWS. Regulations governing the Section 7 consultation process require the FWS to provide its advice and recommendations for ESA compliance in a written BO when a project is likely to adversely affect one or more listed species and/or their designated critical habitat. After completion of a BO, FWS responsibilities include continuing oversight of the Federal agencies compliance with RPAs and terms and conditions included in the incidental take statement portion of the BO, as well as the duty to inform the Federal action agency if available information leads to an FWS determination that ESA requirements are not being met.

1.4.7 Department of Interior Responsibilities and Authorities

Authority for the involvement of the NPS and FWS in the SEIS originates from various laws, agreements, and regulations. Each of these laws, agreements, and regulations are described below.

1.4.7.1 Fish and Wildlife Coordination Act

The FWCA mandates that the Corps coordinate with the FWS and State Fish and Wildlife Conservation Commission regarding fish and wildlife resources. Both NPS and FWS have collaborated to provide this CAR because many of the fish and wildlife resources associated with the project are within ENP. The purpose of the FWCA is to recognize the contribution of these resources to the nation, the increasing public interest and significance thereof due to expansion of our national economy and other factors, and to provide that the conservation of fish and wildlife receives equal consideration and be coordinated with other features of water-resources development programs. The Secretary of the Interior, through the FWS is authorized to assist and cooperate with Federal, state and public or private agencies and organizations in the conservation and rehabilitation of fish and wildlife resources. The FWCA provides that whenever the waters of any stream or other body of water are proposed to be impounded, diverted, the channel deepened or otherwise controlled or modified, the Corps shall consult with the FWS and the agency administering the fish and wildlife resources of the state (Corps 1998). The consultation shall consider conservation of wildlife resources with the view of preventing loss of and damages to such resources as well as providing for development and improvement in connection with such water resources development (Corps 1998). Any reports and recommendations of these fish and wildlife agencies shall be included in authorization documents for construction or for modification of projects. The Corps shall give full consideration to the reports and recommendations of these fish and wildlife agencies and include such justifiable means and measures for wildlife mitigation or enhancement as the Corps finds should be adopted to obtain maximum overall project benefits (Corps 1998).

1.4.7.2 National Environmental Policy Act

In addition to the responsibilities described above, the CEQ regulations and guidelines for implementing NEPA confer specific rights and responsibilities to agencies functioning as cooperating agencies in the NEPA process. A cooperating agency is any agency, other than a lead agency (Corps in this case), that has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal for legislation or other major Federal action that might significantly affect the quality of the human environment.

1.4.7.3 Executive Orders

Executive Orders (EOs) 11988 (Floodplain Management) and 11990 (Protection of Wetlands) require Federal agencies to evaluate the likely impacts of actions to floodplains and wetlands. The objectives of the EOs are to avoid, to the extent possible, the long-term and short-term adverse impacts associated with occupancy, modification, or destruction of floodplains and wetlands and to avoid indirect support of development and new construction in such areas wherever there is a practicable alternative. To document its evaluation for these EOs, the NPS prepares a Statement of Findings that presents the purpose of the proposed project and documents the anticipated effects on wetlands and floodplains.

1.5 Prioritization of Project Objectives

1.5.1 First Priority– Meet RPA Requirements for Sparrow

The project has three objectives, which are approached in order of priority. The highest priority is given to achieving compliance with the ESA by meeting hydrological targets for the CSSS as established in the RPA issued by the FWS. This will be accomplished by first evaluating the hydrological outputs from the SFWMM as simulated for a selection of water management alternatives. This information and evaluation of additional hydrologic analysis presented in Chapter 4 will then be compared with performance measures based on the nesting and habitat requirements of the CSSS in the six sub-populations.

1.5.2 Second Priority– Minimize Impacts to other Listed Species

An important but second-level priority is given to minimizing, in all operations which would be conducted to meet RPA requirements, adverse impacts to other species listed under the ESA. To the extent that alternatives for achieving RPA compliance are available, their differential effects upon other listed species will become a major consideration in recommending an alternative. Several endangered species potentially could be affected by water management actions conducted on behalf of the CSSS. These include the snail kite, wood stork, American crocodile and West-Indian Manatee. Again hydrological model output will be evaluated in terms of performance measures that relate to key aspects of the species life histories.

1.5.3 Third Priority– Minimize Impacts to other Natural Resources

As a third priority, it is important to evaluate to what extent actions taken in meeting the first two priorities (as simulated) affect other ecological resources of the area. Particular attention will be given to such fundamental ecosystem aspects as the water levels and depths needed to support tree island habitats in the WCAs, aquatic plant communities in Shark Slough, the adequacy of flows into Florida Bay to establish healthful salinity regimes, and the minimum groundwater depths found in the marl prairies under varying rainfall conditions.

1.6 Plan Formulation and Evaluation

The plan formulation for the IOP began in March, 2000, with development and modeling of the first set of alternatives. However, earlier modeling for the ISOP also provided information used in IOP development. The Corps also formed an interagency evaluation team for the IOP effort, including representatives of all interested agencies, local governments, agricultural interests, and Native American tribes. The interagency team provided input on each member's priorities for project objectives and evaluations of the impacts of each alternative along with ideas for structural and operational components that would accomplish their objectives. The Corps used this input to develop components for subsequent rounds of modeling using the SFWMM. The results of each iteration of modeling were posted on the Corps' Web site - *http://hpm.saj.usace.army.mil/index.html*, where members of the interagency team and the public could review the results and prepare their comments.

In accordance with our FWCA responsibilities to provide the advice and recommendations of the Secretary of the Interior, NPS and FWS input was summarized and submitted to the Corps in a May 24, 2000, Planning Aid Letter (PAL) shortly after the second interagency team meeting. Due to the Corps' extremely short timeframe for IOP development, DOI did not have time to provide an additional PAL or draft CAR prior to release of the draft EIS. Florida Fish and Wildlife Commission input was submitted in a separate PAL concurring with the DOI's PAL and in some cases, providing additional input. The Corps then formulated and modeled the final set of alternatives.

Because the iterative modeling process was limited due to time constraints, and because the SFWMM results do not provide information at a scale most appropriate for some impact assessments, significant questions remained after our analysis of the Corps' modeling. Additional information was necessary in order to formulate final recommendations for the project. The Corps' timeline would not allow for additional modeling, so NPS staff conducted several additional modeling hydrologic analyses. These are presented in Chapter 4 NPS and FWS used this information, along with our analysis of the Corps' modeling and our analysis of actual data collected during ISOP operations, to formulate the recommendations in this CAR.

1.7 Performance Measures

A number of evaluation tools were used by NPS and FWS to evaluate the outputs of the SFWMM runs. These included Performance Measures, other hydrologic analyses presented in Chapter 4, the Multi-Species Recovery Plan (MSRP) for the Threatened and Endangered Species of South Florida (FWS 1999), scientific literature, and individual expertise. Each alternative was examined in light of the Existing Condition (Alternative 1 = ISOP9D = ISOP 2001)

Performance measures are means of measuring impacts of hydrologic conditions on different attributes of the system and may provide recommendations for directional improvement that do not include quantitative targets, or may specify a quantitative goal for performance. Performance measures used in this CAR are listed below. Most of these performance measures were developed through interagency discussions associated with the Comprehensive Everglades Restoration Plan and MWD planning processes and are widely accepted among scientific experts familiar with the Everglades Ecosystem. A few of the performance measures used in this CAR were developed specifically for this and other similar reports by NPS and FWS staff with particular expertise in each area based on the best scientific information available.

1.7.1 Endangered Species Act Compliance

1.7.1.1 Cape Sable Seaside Sparrow

One important hydrologic measure of the potential for CSSS nesting success is to determine the number of consecutive days between March 1 and July 15 that water levels are below ground surface. This incorporates most of the window when CSSSs have been observed nesting and is an indirect measure of the number of days potentially available for CSSS courtship and nesting. A formal American Ornithological Union (AOU) peer review of biological information on the CSSS conducted in 1999 (Walters et al. 1999) provided specific, peer reviewed recommendations for number of nesting days necessary in sub-population A that are used as our basis for comparison of the performance of alternatives for sub-population A. These recommendations are presented in detail in Chapter 3 and include a minimum of 50-60 consecutive nesting days, preferably 80 consecutive nesting days, in all years until sub-population A numbers have increased to at least 1000 individuals (Walters et al. 1999). Also applicable to sub-population A is the RPA requirement of 60 consecutive days below 6.0 feet at the hydrologic gage NP-205 between March 1 and July 15. For the purposes of this evaluation 60 consecutive days in all years (all return periods) is the condition considered most desirable.

For evaluation of other sub-populations, the following general characterizations are used. Forty consecutive days for 8 out of 10 years is considered favorable for CSSS population persistence, 40 days for 7 out of 10 years is considered borderline for persistence, 80 days for 7 out of 10 years is favorable, and 80 consecutive days for 8 out of 10 years is considered very favorable (S. Pimm, pers. comm., 1999).

The number of available nesting days is not the only important hydrologic measure used to determine the effects of water management scenarios on the CSSS. The hydrologic regime required to maintain the wet prairie habitat is also important. The hydrologic output examined for this performance measure is the number of consecutive days per year that one can expect the CSSS habitats to be flooded. For the purposes of this evaluation, a 0-2 month average continuous hydroperiod is not expected to support vegetation favorable to CSSS nesting, a 2-4 month hydroperiod is considered favorable and supportive of *Muhlenbergia* dominated habitat, a 4-6 month hydroperiod is considered good for other vegetation favorable to CSSS nesting, and a hydroperiod greater than 6 months is not expected to support vegetation favorable to CSSS nesting (Davis 1943; Craighead 1971; Olmstead et al. 1980; Kuslan and Bass 1983; Gunderson 1994; Armentano et al. 1995; Armentano, pers. comm., 1999; Jones, pers. comm. 1999; Bass, pers. comm., 1999 and 2000; Pimm 2000).

In the CSSS populations on the eastern side of Shark Slough, for the purposes of fulfilling the RPA, the target is to match conditions predicted for Test 7 Phase II operations, combined with percentage releases of regulatory flows east through S-333 into the L-29 canal as described in the BO, for the habitat and persistence measures above. Larger improvements in the habitat and persistence measures above are also acceptable.

1.7.1.2 Wood Stork

Analysis of alternative impacts on wood storks were evaluated using the performance measure proposed by Ogden (1998). This performance measure was developed using hydrological indicators which best measure the recovery of optimum foraging conditions for wood storks and is generally accepted as the best performance measure so far developed. Ogden and others have explored other methods of evaluating expected impacts on wood storks resulting from alternative water management scenarios, but have so far not found another method that best predicts performance when compared with data on historical wood stork foraging and nesting patterns (J. Ogden, pers. comm., 2000).

The target for the Ogden (1998) wood stork performance measure is to approximate Natural System Model (NSM) predicted flow volumes and hydroperiod durations for Shark Slough and Taylor Slough. The NSM provides the best available representation of hydrologic conditions prior to large-scale human manipulation. To evaluate an alternative, values for each of these elements are converted to a ratio of the NSM value. A final weighted score is then calculated using a weighting of two for the hydroperiod durations, a weighting of three for the Shark Slough flow volume and a weighting of one for Taylor Slough flow volume. For the purposes of this evaluation final scores within 15% of NSM are considered optimal, values within 16% to 30% of NSM are considered good, values within 31% to 50% are considered marginal and values less than 50% of NSM are considered unsuitable.

1.7.1.3 Snail Kite

To assess the possible effects of water management scenarios or snail kites, the following hydrologic conditions were examined: median hydroperiod, fraction of years with a hydroperiod less than 310 days, fraction of years in which there is a drying event, fraction of years in which there is a drying event lasting 30 days or longer, and fraction of years there is a drying event before May. These parameters were chosen for analysis because they are known to influence the populations of apple snails, the snail kite's main food source, that would be expected in areas that could provide habitat for nesting snail kites (Bennetts et al. 1994; Bennetts and Kitchens 1997; Darby et al. 1997; Bennetts et al. 1998).

Values for each of these parameters were then examined for areas that supported regular snail kite nesting in areas affected by ISOP operations during actual Experimental Water Deliveries Test 7 Phase I (EWDT71) operations. These areas are south WCA-3A (Indicator Region (IR) 14), the western side of WCA-3A, and the extreme southern portion of WCA-3A **(see Figure 5.14)**. We assume that these values represent suitable conditions for snail kite nesting because successful snail kite nesting was consistently observed under these conditions during actual EWDT71 operations. Alternatives were evaluated by comparing suitable parameter values to those predicted by modeling in areas that could support snail kite nesting with WCA-2A, WCA-2B, WCA-3A, WCA-3B, NESS, and Shark Slough.

Also used in the evaluation of alternatives is a summary by basin of the fraction of years there is a drying event at or below ground surface classified as suitable conditions, marginal conditions, or unsuitable conditions for snail kites. The suitability classes are derived from Bennetts (pers. comm., 1998) and Bennetts et al. (1998). The classes represent relative habitat quality in relation to the time since a drying event. Suitable conditions are considered to be when drying events occur at a return frequency between "1-in-3" to "1-in-5" years. If drying events occur too frequently, greater than "1-in-2" years, the apple snail population will not have recovered to its full potential and so conditions are classified as unsuitable. If drying events occur at longer intervals, less than "1-in-6" years, then a cumulative process of habitat degradation will occur as plant communities change. This return frequency is also classified as unsuitable. Return frequencies of "1-in-2" to "1-in-3" years, and "1-in-5" to "1-in-6" years are classified as marginal.

1.7.1.4 Manatees and Crocodiles

Expected alternative performance relative to American crocodile and West-Indian manatee habitats was evaluated through comparison of predicted salinity regimes, average annual flow volumes and monthly flow distributions. For salinity the desired condition is to increase the percentage of time when low salinity (<20 ppt) is expected, and decrease the percentage of time when moderate (20-40 ppt) or high (>40 ppt) salinities are expected. These categories are based on discussions with crocodile and manatee researchers and reflect data showing that crocodile hatchling survival is likely reduced during times of high salinity, and that manatees generally prefer lower salinity habitat (FWS 1999).

As the possible effects on crocodiles and manatees are related to fresh water in flows into the estuaries, it is useful to examine simulated annual flow volumes. The desired condition is to minimize decreases in annual flow volumes into Shark Slough and Taylor Slough.

In addition to flow volume it is useful to look at the monthly distribution of flows towards the estuarine crocodile and manatee habitat of northeastern Florida Bay especially during the initial growth period for crocodile hatchlings, from August – December. The desired condition is to minimize the loss of monthly flows during August – December as compared to Experimental Water Deliveries Test 7 Phase 1.

1.7.2 Other Natural Resources

Performance measures used to evaluate ecological resource concerns other than endangered species are presented below. Discussion of the rationale and the general ecological setting for these measures can be found in Chapter 3. Many of the performance measures were unchanged as the sub-regions were considered sequentially from north to south. Rather than repeat them for each sub-region, widely used performance measures are presented under WCA-3A, with measures specific to a sub-region described under that sub-region.

1.7.2.1 WCA-3A

1.7.2.1.1 Tree Islands

Tree islands were evaluated based on the assumption that when water depths exceed certain depths, the tree island vegetation is subjected to flooding stress, an undesirable condition. The elevation of a given tree island above the marsh soil surface to a large extent determines its tendency to flood. Thus a performance measure can be developed based on a given water level that is in turn dependent on the elevation difference between two points in a marsh. This concept is employed as a guideline by which to evaluate alternatives although it does not consider elevation differences within the tree islands itself nor the flooding tolerances of the species occupying the tree island, two variables which must be known to fully understand the response of tree islands to flooding. In fact research shows that there are widely varying plant communities found in tree islands of the southern Everglades region and that these communities and their constituent species vary in their hydrological tolerances. Therefore the performance measures adapted here are best viewed as simplified metrics suitable for comparing alternatives for their effects on idealized tree islands rather than on actual tree islands with specific locations.

Although more data on the effects of high water conditions on tree islands are needed, much can be learned from reviewing information on the high water period of 1994-95 (Armentano 1996). The available information on water depths and elevations of plant communities (including tree islands) in Shark Slough suggests that marsh water depths in excess of 2.5 or even 3 feet for weeks to months do not lead to long-term deleterious effects on the trees growing in: 1) hardwood hammocks, 2) the adjacent, downstream bayswamp forest communities, or 3) bayheads. For example, at the mid slough hydrological stations NP-201, NP-203, P-33, mean depths exceeding 2.5-3.0 feet (depending on station) were recorded in the period extending from November 1994 to February 1995 . Aerial and ground surveys which were made of vegetation and wildlife status in over 20 tree islands from November 1994 through February 1995, revealed that hammock trees show no symptoms of flooding stress other than minor leaf discoloration in a few species despite that some of the hammocks experienced surface water in lower portions for varying lengths during the period, a condition similar to that of 1969-70, another high water year (Olmsted and Armentano 1997). Later observations in the mid and late 1990's confirmed that there were no delayed symptom expression traceable to the 1994-95 high water period and that canopy condition of trees in the tree island hammocks were closely similar to pre-high water conditions. For these reasons, limiting marsh water depths to 2 feet in order to prevent hammocks from surface water is not necessary, nor should it be assumed that surface water of any duration causes significant harm to hammock tree communities.

The bayswamp and bayheads, which occur at lower elevations that the hammocks ordinarily experience flooding for long periods in non-drought years, and sometimes approaching 12 months as in 1994-95. However in 1994-95, these stands, because they are comprised of species adapted to saturated soil conditions, maintained stand integrity without mortality of more than individual trees, a common condition in these communities. The reconstruction by Ross et al. (2000) of the flooding depths and durations in 11 bayswamp and bayheads in Shark Slough during the decade of the 1990s confirms the record of protracted inter-annual flooding of intact communities.

Because of the vulnerability of tree islands to fire damage in droughts, an assessment of fire risk is important although there are few data available for constructing a quantitative performance measure. Three model output hydrographs were reviewed to compare alternatives and the base in terms of the relative risk that fires would damage tree islands:

Annual minimum stage – the assumption is made that the lower the minimum stage, the greater is the fire risk. This and the following pair of measures were applied to the drought periods as presented in hydrographs showing water level exceedances across a range of hydrologic return intervals.

30-day dryouts – the assumption is made that fire risk increases with the increasing depth of the water table in the driest 30 day continuous period of the year.

Consecutive days in which the ground water level falls 1.5 feet or more below ground. Based on Craighead (1971), fires causing heavy damage to tree islands occurred when ground water levels fell beneath two feet. To minimize reaching this state, we used a minimum of 1.5 feet below the ground surface as an index of when fire risk becomes high.

1.7.2.1.2 Slough Vegetation

The essential hydrological conditions needed to support fully functioning freshwater peat-accreting slough communities include the presence of relatively deep, slowly flowing water in marshes for extended durations which can continue across multiple years. At the opposite extreme, in drought years, relatively short durations when the water table falls below the marsh surface also can occur under natural conditions. However, these drawdowns are relatively uncommon such that the mean annual hydroperiod over several decades in peat-accreting sloughs is considered to fall within the range of 11-12 months.

Embodying this range of conditions, comparisons among alternatives were first made based on the duration of continuous hydroperiods (defined as periods with surface water above 1.0 feet) with an annual average of 11-12 months. The 1.0 feet criterion was selected to provide a depth that is needed for the hydrophytic species characteristic of sloughs (e.g., *Nymphaea odorata*, *Nymphoides aquatica*, *Pontederia cordata*, etc.) as opposed to the shallower depths more commonly found in seasonally inundated marl prairies. This guideline and the two following are related to the importance of uninterrupted flooding of relatively deep water to the development of peat-forming aquatic slough plant communities.

Annual minimum surface water depths-, based on the consideration that non-slough marsh communities commonly develop in shallowly flooded conditions, alternatives with the highest minimum water depths were judged superior relative to each other and to the base. However, water depths exceeding depths of around 2.5 feet when they persist for many months as in WCA-3A are believed to be excessive relative to natural conditions for natural slough development and persistence. Therefore if, in an alternative, the minimum water depths did not fall below 2.0 feet, the alternative was considered as unacceptable relative to this specific criterion.

Durations of water levels below ground – based on the consideration that water table withdrawals below the marsh surface are both infrequent and shallow in slough. Alternatives with the shortest duration when the water table falls below the ground surface are considered superior relative to each other and the base.

1.7.2.1.3 Water Quality

30-day dryouts – based on the finding that mobilization and transfer of phosphorus into wetlands is stimulated by oxidation of sediments and by muck fires, alternatives can be compared relative to their risk of producing the low water conditions that promote phosphorus mobilization. Therefore alternatives and the base were compared relative to the water level depths developed during continuous 30 day dryouts.

1.7.2.1.4 Wading Bird Foraging Habitat

A qualitative evaluation by wildlife biologists was made of the suitability of water depths at appropriate seasons of the year for wading bird foraging as basis for ranking alternatives relative to each other and the base. This evaluation incorporated timing (i.e., the presence of water depths appropriate to the phenological stage of wading bird life cycles), and the number of depth reversals during these periods. In the latter case, sudden reversals in water depths have been observed to occur in the managed system with destructive effects upon foraging success. Therefore, alternatives with the fewest number of reversals, particularly if these involve large changes in depths or any changes resulting in a loss of surface water, are considered superior. In addition, the availability of prey can also be directly considered by incorporating the aquatic animal community measures (see below) in the evaluations.

1.7.2.1.5 Aquatic Animal Communities

Similar to aquatic vegetation, continuous durations of surface water are important for slough animals. The larger fish characteristic of sloughs require extended durations of water depths of at least 10 inches. Several years of continuous duration in which water depths remain at or above this level is considered as essential for supporting fully functioning aquatic animal communities. As a guideline, alternatives and the base were compared relative to their capacity to provide average hydroperiods with water depths of at least 12 inches for 11-12 months.

1.7.3.1 WCA-3B

Performance measures are identical to those for WCA-3A.

1.7.4.1 Northeast Shark Slough

Performance measures are identical to those used in WCA-2 and WCA-3, except that for water quality, alternatives were ranked based on the source of water. Water reaching ENP from WCA-3 has remained within the Everglades, a pathway shown to result in lower phosphorus content than water that enters ENP from outside the Everglades system. Therefore alternatives were compared based on the relative proportion of inflow water originating from within, or external to, the Everglades wetland system.

1.7.5.1 Rocky Glades

1.7.5.1.1 Water Quality

The same performance measure used for Northeast Shark Slough was used for the Rocky Glades.

1.7.6.1 Southern Shark Slough

Most of the performance measures for Shark Slough were identical to those of WCA-3 except that for tree islands-only water depths exceeding 24 inches were considered because research in ENP has shown that marsh water depths of 18 inches cause no demonstrable adverse effects on tree island vegetation. In addition the water quality performance measure used in southern Shark Slough was identical to the one used in Northeast Shark Slough.

1.7.7.1 Estuaries

1.7.7.1.1 Shark Slough Estuaries

The apparent effects of the alternatives and the base on the salinity of the North River which empties into Whitewater Bay, were compared by using the regression relationship between stage at the P-33 monitoring station predicted from hydrological model outputs and salinity predictions. Based on research on salinity preferences by important species like spotted sea trout and pink shrimp, the performance measure ranked alternatives and the base according to the number of months over the 31-year simulation period in which mean salinity estimates fell within three classes- less than 20 parts-per-thousand (ppt), from 20 to 40 ppt, and more than 40 ppt. The alternative which minimized the number of months in which salinities exceeded 40 ppt was considered superior.

1.7.7.1.2 Florida Bay

Total annual discharge expressed as mean monthly flow across a Taylor Slough cross-section was used as a surrogate to evaluate the effects of the alternatives on the seasonal timing of salinity patterns in downstream embayments (e.g. Little Madeira Bay). Alternatives that minimized a departure from the EWDT71 base towards reduced late dry season-early wet season flows, or increased these flows, would be preferred, because reduced flows at this time allow greater hypersalinity than would occur with higher flows.

Literature Cited

Armentano, T. V. 1996 (ed.). Ecological Assessment of the 1994-95 High Water Conditions in the Southern Everglades. Proceedings of the Conference held at Florida International University, August 1996. Held under auspices of Science Sub-Group, South Florida Management and Coordination Working Group.

Armentano, T.V., R.F. Doren, W.J. Platt and T. Mullins, 1995. Effects of Hurricane Andrew on coastal and interior forests of southern Florida: overview and Synthesis. J. Coastal Res. Spec. Issue No. 21:111-144.

Bennetts, R.E., M.W. Collopy and J.A. Rodgers. 1994. The Snail Kite in Florida in the Florida Everglades: a food specialist in a changing environment. Pp. 507-532 in S. M. Davis and J.C. Ogden (eds.). Everglades: the ecosystem and its restoration, St Lucie Press, Delray Beach.

Bennetts, R. E. and W. Kithches 1997. The Demography and Movements of Snail Kites in Florida. Tech. Rpt. No. 56, U.S. Geol. Survey/Biol. Res. Div., Florida Cooperative Fish & Wildlife Unit, Gainesville, Fl.

Bennetts, R.E., W.M. Kitchens, and D.L. DeAngelis. 1998. Recovery of the snail kite in Florida: Beyond a reductionist paradigm. In Trans. 63rd No. Am. Wildl. And Natur. Resour. Conf.

Council on Environmental Quality. 1981. Forty most asked questions concerning NEPA regulations (40 CFR 1500-1508). Federal Registar 46(55):18026-18038

Craighead, F.C., Sr. 1971. The Trees of South Florida. University of Miami Press, Coral Gables, Fl. 212p.

Darby, P.C. Valentine Darby, R.E. Bennets, J.D. Croop, H.F. Percival, and W.M. Kitchens. Ecological studies of apple snails (*Pomacea paludosa, say*). Technical Report, Florida Cooperative Fish and Wildlife Research

Unit, Gainesville, Florida, 1997. Final Report prepared for South Florida Water Management District and St. Johns River Water Management District, Contract #E-6609.

Davis, J.H. Jr. 1943. The natural features of southern Florida, especially the vegetation, and the Everglades. Fla. Geol. Surv. Bull., No. 25.

Gunderson, L.H. 1994. Vegetation of the Everglades: Determinants of Community Composition. In S.M. Davis and J.C. Ogden, Eds., Everglades and its Restoration. St. Lucie Press, Delray Beach, FL.

Kuslan and Jacobson 1990Kushlan, J. A., and T. Jacobsen. 1990. Environmental variability and the reproductive success of Everglades alligators. J. Herpetol. 24:176-184.

Kushlan, J. A. and O. L. Bass Jr. 1983. Habitat use and the distribution of the Cape Sable sparrow. Pp. 139-146 *in* The Seaside Sparrow, its biology and management (T. L. Quay, J. B. Funderburg, Jr., D. S. Lee, E. F. Potter, and C. S. Robbins, eds.). Occas. Pap. North Carolina Biol. Surv., Raleigh, NC.

National Park Service 1995. A Hydrological Evaluation of the Experimental Water Deliveries to Everglades National Park, Test 6 Iteration. Tech Report, SFNRC, Homestead, FL.

Neidraurer, C. J. and R.M. Cooper. 1989. A Two year Field test of the rainfall Plan: A Management Plan for water deliveries to Everglades national Park. Technical Report 89-3, South Florida Water Management District, West Palm Beach, Florida.

Ogden, J.C. 1998. Endangered species performance measures (wood stork). Document prepared as part of the Southern Everglades Restoration Alliance planning process, South Florida Water Management District, West Palm Beach, FL.

Olmstead, I.C., L.L. Loope, and Rintz. 1980. A Survey and Baseline Analysis of Aspects of the Vegetation of Taylor Slough, Everglades National APArk, Report T-586, SFRC, National Park Service, Homestead, FL.

Olmsted, I.O. and T.V. Armentano 1997. Vegetation of Shark Slough, Everglades National Park. SFNRC Tech. Rpt. 97-001. Everglades National Park, 41 pp.

Pimm et al. 2000. 2000 Cape Sable seaside sparrow annual report.

Ross, M. S., P. Ruiz, D. Reed, K. Jayachandran, J. Sah, M. Lewin 2000. Assessment of marsh vegetation responses to hydrological restoration in Shark Slough, Everglades National Park. Annual Report, 1999-2000/

U.S. Army Corps of Engineers. 1995. Environmental Assessment and Finding of No Significant Impact: Test Iteration 6, Experimental Program of Water Deliveries to Everglades National Park, Jacksonville, Florida.

U.S. Army Corps of Engineers. 1997. Environmental Assessment and Finding of No Significant Impact: Test Iteration 7, Experimental Program of Water Deliveries to Everglades National Park, Jacksonville, Florida.

U.S. Fish and Wildlife Service. 1999. Multi-species recovery plan for the threatened and endangered species of south Florida, Volume 1 of 2, Vero Beach, FL.

Van Lent, Thomas J., R. Johnson, and R. Fennema. 1993. Water Management in Taylor Slough and its effects on Florida Bay. Technical Report SFRC 93-03, Everglades National Park, Homestead, Florida.

Van Lent, T., R.W. Snow and F.E. James. 1999. An examination of the modified water deliveries project, the C-111 Project, and the experimental water deliveries project: hydrologic analyses and effects on endangered species. South Florida Natural Resources Center, Everglades Nat. Park, Florida.

Chapter 2– Area Setting

2.1 Project Location

The study area comprises the majority of the original MWD Project, but specifically excludes two features included in the original MWD General Design Memorandum- the 8.5 Square Mile Area and raising of the Tamiami Trail roadbed. The primary area in which hydrology and ecology could be affected by these alternatives includes Shark Slough, Northeast Shark Slough (NESS), western Shark Slough and Florida Bay portions of ENP, eastern portions of Big Cypress National Preserve, remaining privately-owned lands in NESS and four other substantial areas of historic Everglades: WCA-3A, WCA-3B, WCA-2A and WCA-2B. The project area includes some of the most significant wildlife habitat in Florida and totals over 1,200,000 acres. Some of the alternatives have additional, indirect impacts on other areas of concern, including Biscayne National Park, public and private lands adjacent to the SDCS, and the C-111 basin.

2.2 Description of Study Area

The Corps' 1999 Final Integrated Feasibility Report and Programmatic Environmental Impact Statement for the C&SF Project Comprehensive Review Study includes excellent descriptions of the entire C&SF Project area. Portions of these descriptions addressing the IOP study area are reproduced below.

2.2.1 Geology and Soils

The Big Cypress Basin developed on top of sandy, marly, fossiliferous limestone and sand of the Tamiami Formation of Pliocene epoch. Fine sand and loamy soils with poor natural drainage and scattered areas of rock outcrop overlie the limestone of the Big Cypress Basin. The sandy and loamy soils of the Upper East Coast and the Caloosahatchee River Basin lie on top of the Anastasia Formation of variably shelly and sandy limestone and provide moderate natural drainage.

The WCAs are primarily underlain by peat and muck (histosols of organic origin and entisols) although much of the peat has been altered to muck by oxidation processes. Other soils in these areas include fine sand and loamy material that have poor natural drainage (predominantly alfisols and entisols with histosols).

The Lower East Coast has several predominant soil characteristics, including sandy and sandy-over-loamy soils with moderate natural drainage (spodosols and alfisols). To the west of the Atlantic Coastal Ridge, soils contain fine sand and loamy material and have poor natural drainage (predominantly alfisols and entisols with some histosols). In coastal areas the soils are predominantly sandy although some organic soils are scattered throughout (entisols, histosols, and some alfisols). There are also areas where rock outcrops sometimes referred to as "rockland" or a weathered rock surface (caliche and entisols of recent limestone origin) occur. Rock outcrops are characterized by karst features such as solution pits, caves and sinkholes. Commonly the rock surface is extremely rugged and pitted. Pits in the rock surface range from several inches to several feet in diameter and depth. Where soils occur on these rock surfaces, they are primarily entisols, but may also include alfisols and histosols.

ENP is underlain by peat and muck (histosols of organic origin and entisols) although much of the peat has been altered to muck by oxidation processes. There are also areas where rock outcrops or a weathered rock surface (caliche and entisols of recent limestone origin) occur. Rock outcrops are characterized by karst features such as solution pits, caves and sinkholes. Commonly the rock surface is extremely rugged and pitted. Pits in the rock surface range from several inches to several feet in diameter and depth. Where soil development has occurred on these surfaces, soils are primarily entisols but may also include alfisols and histosols.

Florida Bay, Whitewater Bay, and the Ten Thousand Islands area are underlain by exposed rock surfaces and modern sediment. On islands and in coastal areas, soils are predominantly sandy although some organic soils are scattered throughout (entisols, histosols, and some alfisols). Exposed rock surfaces also occur and are characterized by karst features such as solution pits, caves and sinkholes. Commonly the rock surface is extremely rugged and pitted. Pits in the rock surface range from several inches to several feet in diameter and depth. Where soil development has occurred, soils are primarily entisols but may also include alfisols and histosols.

2.2.2 Hydrological Description

The subtropical climate of south Florida, with distinct wet and dry seasons, high rates of evapotranspiration, and climatic extremes of floods, droughts and hurricanes represents a major physical driving force that sustains the Everglades while creating water supply and flood control issues in the agricultural and urban segments. South Florida's climate, in combination with low topographic relief, delayed the development of south Florida until the Twentieth Century, provided the main motivation for the creation of the C&SF Project fifty years ago, and continues to drive water management planning today.

Seasonal rainfall patterns in south Florida resemble the wet and dry season patterns of the humid tropics more than the winter and summer patterns of temperate latitudes. Of the 53 inches of rain that south Florida receives annually on the average, 75 percent falls during the wet season months of May through October. During the wet season, thunderstorms that result from easterly tradewinds and land-sea convection patterns occur almost daily. Wet season rainfall follows a bimodal pattern with peaks during May-June and September-October. Tropical storms and hurricanes also provide major contributions to wet season rainfall with a high level of interannual variability and low level of predictability. During the dry season, rainfall is governed by large-scale winter weather fronts that pass through the region approximately weekly. High evapotranspiration rates in south Florida roughly equal annual precipitation. Recorded annual rainfall in south Florida has varied from 37 to 106 inches, and interannual extremes in rainfall result in frequent years of flood and drought. Multi-year high and low rainfall periods often alternate on a time scale approximately on the order of decades.

South Florida contains three major carbonate aquifer systems. The surficial aquifer system comprises rocks and sediments from the land surface to the top of an intermediate confining unit. The discontinuous and locally productive water bearing units of the surficial aquifer include the Biscayne Aquifer, the undifferentiated surficial aquifer, the coastal aquifer of Palm Beach and Martin counties and the shallow aquifer of southwest Florida. Practically all municipal and irrigation water is obtained from the surficial aquifer system. The intermediate aquifer system consists of beds of sand, sandy limestone, limestone and dolostone that dip and thicken to the south and southwest. In much of south Florida, the intermediate aquifer represents a confining unit that separates the surficial aquifer system from the Floridan aquifer system. In the Lower Floridan aquifer there are zones of cavernous limestones and dolostones with high transmissivities. However, because these zones contain saline water, they are not used for drinking water supply and are used primarily for injection of treated effluent wastewater.

2.2.3 Ecological Description

2.2.3.1 Fish and Wildlife Resources

Originally authorized by Congress in 1948, the C&SF Project has resulted in the channelization, compartmentalization and drainage of vast areas of the south Florida ecosystem for the stated purposes of meeting water supply and flood control needs. Considered to be the most complex waterworks in the United States, the project consists of more than 1,400 miles of canals and levees, more than 2,000 water control structures and pump stations, and approximately 256,000 acres of WCAs. The originally authorized C&SF Project has not been fully constructed to date.

Construction of the C&SF Project over the past 50 years has resulted in extensive urban and agricultural development that now shapes the south Florida landscape. It is fair to conclude that the south Florida landscape has been extensively altered and damaged and that ecosystem health and stability have declined as a consequence.

Today, scientists have recognized and documented that there will be a continued decline of the south Florida ecosystem if nothing is done to stabilize ecological integrity. The current condition of the ecosystem demonstrates the decline to date: wading bird populations in the southern Everglades have declined by 90 percent, 68 species have been listed as threatened or endangered, exotic invasive plant and animal species have infested large areas of the ecosystem, coastal estuaries continue to be damaged by discharges of large volumes of freshwater, and the overall spatial extent of the Everglades wetland ecosystem has declined by 50 percent and continues to decline at an alarming rate.

2.2.3.2 Federally-listed and State-listed species

A variety of species listed as threatened, endangered, or of special concern occur or potentially occur in the study area **(Table 2.1)**. Federally-listed species that occur in the action area and could be affected by the IOP include the Cape Sable seaside sparrow (*Ammodramus* (*=Ammospiza*) *maritimus mirabilis*), snail kite (*Rostrhamus sociabilis plumbeus*), wood stork (*Mycteria americana*), Florida panther (Puma (*=Felis*) *concolor coryi*), eastern indigo snake (*Drymarchon corais couperi*), West Indian manatee (*Trichechus manatus*), American crocodile

Table 2.1 Species Listed by Florida Game and Freshwater Fish Commission as Threatened, Endangered, and Species of Special Concern, Excluding Federally-listed Species

Common Name	Scientific Name	Designated Status
Reptiles and Amphibians		
Miami black headed snake	*Tantilla oolitica*	Threatened
American alligator	*Alligator mississipiensis*	Special Concern
Gopher tortoise	*Gopherus polyphemus*	Threatened
Birds		
Roseate spoonbill	*Ajaia ajaja*	Special Concern
Limpkin	*Aramus guarauna*	Special Concern
Little blue heron	*Egretta caerulea*	Special Concern
Reddish egret	*Egretta rufescens*	Special Concern
Tricolored heron	*Egretta tricolor*	Special Concern
Snowy egret	*Egretta thula*	Special Concern
White ibis	*Eudocimus alba*	Special Concern
Florida sandhill crane	*Grus canadensis pratensis*	Threatened
American oystercatcher	*Haematopus palliatus*	Special Concern
Osprey	*Pandion haliaetus*	Special Concern
Brown pelican	*Pelecanus occidentalis*	Special Concern
Fish		
Mangrove rivulus	*Rivulus marmoratus*	Special Concern
Common snook	*Centropomus undecimalis*	Special Concern
Mammals		
Everglades mink	*Mustela vison evergladensis*	Threatened
Sherman's short-tailed shrew	*Blarina carolinenis shermani*	Special Concern
Florida mastiff bat	*Eumops glaucinus floridanus*	Endangered
Mangrove fox squirrel	*Sciurus niger avicennia*	Threatened
Florida black bear	*Ursus americanus floridanus*	Threatened
Invertebrates		
Florida tree snail	*Liguus fasciatus*	Special Concern

Source: Florida Game and Freshwater Fish Commission 1997.

(*Crocodylus acutus*) and American alligator (*Alligator mississippiensis*) (listed as threatened due to similarity of appearance). Other Federally-listed species that may occur in the action area, but are unlikely to be affected by the project are the Atlantic loggerhead turtle (*Caretta caretta caretta*), Atlantic green turtle (*Chelonia mydas mydas*), leatherback turtle (*Dermochelys coreiacea*), Atlantic hawksbill turtle (*Eretmochelys imbricata imbricata*), Atlantic ridley turtle (*Lepidochelys kempii*), Atlantic salt marsh snake (*Nerodia fasciata taeniata*), bald eagle (*Haliaeetus leucocephalus*), piping plover (*Charadrius melodus*), Kirtland's warbler (*Dendroica kirtlandii*), arctic peregrine falcon (*Falco peregrinus tundrius*), red-cockaded woodpecker (*Picoides borealis*), Audubon's crested caracara (*Polyborus plancus audubonii),* Bachman's warbler (*Vermivora bachmanii),* Okeechobee gourd (*Cucurbita okeechobeensis*), crenulate leadplant (*Amorpha crenulata*), deltoid spurge (*Euphorbia deltoidea*), Small's milkpea (*Galactia smallii*), tiny polygala (*Polygala smallii*) and Garber's spurge (*Euphorbia garberi*).

2.2.3.3 Other Fish and Wildlife Resources

The following descriptions are exerpted from the Corps' 1999 Final Integrated Feasibility Report and Programmatic Environmental Impact Statement for the C&SF Project Comprehensive Review Study.

2.2.3.3.1 Vegetation

The location of south Florida between temperate and subtropical latitudes, its proximity to the West Indies, the expansive wetland system of the greater Everglades, and the low levels of nutrient inputs under which the Everglades evolved all combine to create a unique and species rich flora and vegetation mosaic. Today nearly all aspects of south Florida's native vegetation have been altered or eliminated by the development, altered hydrology, nutrient inputs, and spread of exotics that have resulted directly or indirectly from a century of water management. The mosaic of macrophyte and tree island communities of the remaining Everglades within the WCAs and ENP is altered even in seemingly remote areas by changes in hydrology, exotic plant invasion, and/or nutrient inputs.

The problems of the Everglades extend to the mangrove estuary and coastal basins of Florida Bay, where the forest mosaics and submerged aquatic vegetation show the effects of diminished freshwater heads and flows upstream that are exacerbated by sea level rise. The upland pine and hardwood hammock communities of the Atlantic Coastal Ridge, interspersed with wet prairies and cypress domes and dissected by "finger glades" water courses that flowed from the Everglades to the coast, remains only in small and isolated patches that have been protected from urban development. In contrast, much of the vegetation mosaic in Big Cypress Swamp to the west of the Everglades remains relatively intact. The importance of south Florida's vegetation, in regard to its unique and diverse composition as well as to its critical linkage to the region's fauna, make its current state of degradation a major concern and objective in any project altering water management in this area. More detailed documentation of existing vegetation focuses on wetland systems that have been most seriously degraded and that receive most benefits from restoration efforts. Those systems include the Everglades peatland, the Everglades marl prairie and Rocky Glades, and the mangrove estuaries and coastal basins of Florida Bay.

The Everglades peatland that remains in the WCAs and in Shark Slough of ENP consists of a mosaic of sawgrass (*Cladium jamaicense*) strands, wet prairies, sloughs and tree islands that are oriented in the directions of flow patterns in the pre-drainage system. Sawgrass commonly forms monospecific strands throughout Everglades peatlands. Cattail (*Typha* sp.) has replaced sawgrass in phosphorus enriched areas, and the exotic melaleuca (*Melaleuca quinquenervia)* has invaded sawgrass in peripheral and overdrained areas. A less dense wet prairie community characterized by spikerush (*Eleocharis* spp.), maidencane (*Panicum hemitomon*), and other emergent macrophytes grows at slightly lower elevations than sawgrass. The wet prairie blends into a more open water floating and aquatic community characterized by white water lily (*Nymphaea odorata*) and bladderwort (*Utricularia* spp.) in the lowest elevation water courses between the sawgrass ridges.

Wet prairies and sloughs support a luxuriant growth of attached algal communities known as periphyton, which form an important base of aquatic food webs and which are also diagnostic of water quality and hydrologic conditions in the Everglades. Wet prairies and sloughs also provide habitat for aquatic fauna and for feeding wading birds. Sawgrass is filling in wet prairies and sloughs in much of the remaining Everglades peatlands, probably as a result of lowered water levels. Sawgrass has been observed to revert to wet prairie after peat-burning fires. Cattail is filling wet prairies and sloughs in phosphorus enriched areas.

Tree islands dot the landscape in the form of either teardrop-shaped larger islands or round smaller islands. The heads of larger teardrop-shaped islands support swamp forest trees such as red bay (*Persea borbonia*), wax myrtle (*Myrica cerifera*) and dahoon holly (*Ilex cassine*) in the WCAs and tropical hardwood trees such as gumbo limbo (*Bursera simaruba*), pigeon plum (*Coccoloba diversifolia*) and West Indian mahogany (*Swietenia mahogani*) in ENP. The tails of the islands often support willow (*Salix caroliniana*) and other more water-tolerant species. The smaller round islands are referred to as battery islands or bay heads and support willows or swamp forest species. In one study, a larger island was estimated to have originated approximately 1,200 years ago, and a smaller ones are about 700 years ago. Tree islands provide essential habitat not only for their unique forest plant assemblages but also for the vertebrate species that depend upon them, particularly during high water. Tree islands have been destroyed or damaged both by lowered water levels, which have resulted in tree island and underlying soil burnout, and by unnaturally high water levels that have killed the less water tolerant tree species.

The higher elevation wetlands that flank either side of Shark Slough in ENP support the highly diverse landscape of the marl prairie and Rocky Glades. This mosaic of short stature sawgrass, wet prairie, muhly (*Muhlenbergia capillaris*) prairie, and tropical hammock tree islands grows on marl and exposed limestone substrate in areas where the marsh naturally would dry for two to four months during most years. The wet prairie community of the marl prairie and Rocky Glades shares some species with the wet prairies described above for Everglades peatlands, but it grows under drier conditions and includes the most species rich wetland plant assemblage in the Everglades. The wetland communities of the marl prairie and Rocky Glades support a distinct calcareous periphyton mat from which the marl substrate is formed. The periphyton mat is an important base for aquatic food webs and protects aquatic fauna from desiccation during dry periods. The muhly prairie community is particularly important as critical habitat for the endangered sparrow. The FWS has determined that current water management practices degrade marl prairie habitats essential to the sparrow, adversely modify the sparrow's designated critical habitat and jeopardize the sparrow's continued existence (FWS 1999).

Tree islands in this landscape support a diverse assemblage of tropical hardwood species mixed with temperate species. Shortened annual duration of flooding in the marl prairie and Rocky Glades landscape presently supports a primarily terrestrial community that is flooded briefly each year rather than a primarily aquatic community that dries briefly each year. Impacts to vegetation include the loss of species richness in wet prairie communities, the conversion of muhly prairie and mixed species prairie to sawgrass, the invasion of woody and exotic trees and shrubs into prairie communities, and tree island burnout.

The mangrove estuary between the freshwater Everglades and Florida Bay supports a mosaic of mangrove forests, tidal creeks, salt marshes, coastal lakes, tropical hardwood hammocks, and Florida Bay coastal basins. Red mangrove (*Rhizophora mangle*) swamp dominates the landscape along with stands of buttonwood (*Conocarpus erectus*), black mangrove (*Avicennia germinans*) and white mangrove (*Laguncularia racemosa*). Tidal creeks dissect the mangrove forests and are often bordered by salt marsh communities of black rush *(Juncus roemarianus)* and cord grass (*Spartina* spp.). Tropical hardwood hammocks with canopy trees such as West Indian mahogany, Jamaica dogwood (*Piscidia piscipula*), strangler fig (*Ficus aurea*) grow on elevated coastal embankments. Coastal lakes and basins support seasonally variable beds of submerged aquatic macrophytes that range from low-salinity to marine communities of musk grass (*Chara* spp.*)*, widgeon grass (*Ruppia maritima*), Cuban shoal grass (*Diplanthera wrightii*) and turtle grass (*Thalassia testudinum*). Reduction in freshwater heads and flows from the Everglades, in concert with sea level rise, has caused community shifts in the submerged aquatic vegetation of the coastal lakes and basins and apparently has contributed to the filling in of tidal creeks. A salinity regime favoring an increased frequency of high salinity events and a decreased frequency of low salinity events in the coastal lakes and basins has resulted in the loss of the low-to-moderate salinity macrophyte communities that seasonal populations of migratory waterfowl once utilized. Tidal creeks, with open water and visibly high flow velocities and freshwater flora and fauna that were observed earlier this century, have filled with red mangrove to the point they are no longer recognizable today.

2.2.3.3.2 Wildlife

A critical link in the aquatic food webs, and one that appears to have been broken by hydrologic alterations, is the intermediate trophic level of the small aquatic fauna. The small marsh fishes, macroinvertebrates and herpetofauna form the link between the algal and detrital food web bases of the Everglades and the larger fishes, alligators and wading birds that feed upon them. Aquatic fauna populations are currently diminished due to two factors related to water management. Reduction in the spatial extent of Everglades wetlands by half has resulted in a proportional reduction in habitat of aquatic organisms, and changes in the hydrology in remaining wetlands has further reduced their populations. In the freshwater Everglades, population densities of marsh fishes such as the golden topminnow (*Fundulus chrysotus*), bluefin killifish (*Lucania goodei*), sailfin molly (*Poecilia latipinna*), mosquitofish (*Gambusia affinis*), flagfish (*Jordanella flori-*

dae) and small sunfish (*Lepomis* sp.) are directly proportional to the duration of uninterrupted flooding. This fish assemblage proliferates under extended periods of flooding and may reach maximum population densities only after five to six years of continuously flooded conditions in Shark Slough. In adjacent areas of higher elevation marl marshes and Rocky Glades that tend to dry annually, survivors must repopulate each year after retreating into refugia that hold water through the dry season such as alligator holes, solution holes in exposed limestone, algal mats, and longer-hydroperiod marshes of Shark Slough. The existing duration of uninterrupted flooding in Shark Slough averages less than two years, compared to more than 15 years pre-drainage. In the marl marshes and Rocky Glades, where the duration of uninterrupted flooding currently averages only about three months compared to nearly ten months pre-drainage, the refugia that once enabled the survival of aquatic fauna through droughts now often dry completely, and repopulation requires longer distance migration from the longer-hydroperiod marshes of Shark Slough which also dry frequently. Existing conditions thus suppress the marsh fish populations of Shark Slough and the marl prairies and Rocky Glades at perpetually low densities compared to pre-drainage conditions.

Aquatic macroinvertebrates and marsh fishes are important in food webs. The amphipod (*Hyallela aztecus*), the freshwater prawn (*Palaemonetes paludosus*), the crayfish (*Procambarus alleni*), and the apple snail (*Pomacea paludosa*) represent ubiquitous and highly abundant processors of detritus and algae that must play key roles as prey species and in the cycling of energy and nutrients through the aquatic food webs of the Everglades and other south Florida wetlands. The crayfish is particularly important in the diet of white and glossy ibis (*Plegadis falcinellus*). The apple snail is the sole food of the snail kite. The habitat requirements, life histories and population dynamics of most aquatic invertebrates remain largely unknown.

Also abundant in the freshwater aquatic community are amphibians and reptiles including the squirrel (*Hyla squirella*) and green treefrogs (*H. cenerea*), ranid frogs such as the pig frog (*Rana grylio*) and southern leopard frog (*R. utricularia*), legless siren (*Siren lacertina*) and amphiuma salamanders (*Amphiuma means*), water snakes (*Natrix* sp.) and cottonmouths (*Agkistrodon piscivorus*), and the, red-bellied (*Pseudemys nelsoni*), and mud turtles (*Kinosternon subrubrum steindachneri* and *K. baurii*). Amphibia and their larvae represent important prey species for larger predatory fishes, and wading birds. Turtles, snakes and amphibians are commonly consumed by alligators. The pig frog is commercially harvested for frog legs. The high numbers of herpetofauna in the Everglades, particularly of such ubiquitous and abundant species as the squirrel tree frog, suggest that they must function as critical energy pathways in food webs. Anecdotal accounts of the Everglades from early this century describe a much greater abundance of amphibians and reptiles compared to densities observed today.

Included in the freshwater aquatic community of south Florida are the larger sport species such as the largemouth bass (*Micropterus salmoides*), sunfishes and black crappie (*Lepomis nigromaculatus*) and important non-sport predators such as Florida gar (*Lepisosteus platyrhincus*) and bowfin (*Amia calva*). Largemouth bass also naturally inhabit the deeper-water sloughs and wet prairies of the Everglades, where they grow at a rate of one pound per year of uninterrupted flooding. Wet prairies, sloughs and alligator holes are also the natural habitat of gar and bowfin. Shortened hydroperiods in much of the Everglades in combination with compartmentalization presently confine larger bass mostly to canals, which provide a popular recreational fishery. Unfortunately, Everglades bass contain high body burdens of mercury, presumably through biomagnification in the food chain, which make them unsuitable for frequent human consumption.

The American alligator is a keystone species in the Everglades. Holes that are excavated by alligators form ponds where aquatic fauna survive droughts, and mounds of sediment that are excavated from the holes create higher-elevation habitat upon which willow and other swamp forest trees grow. In addition to its keystone role in the creation of alligator holes, the American alligator is the top predator in the Everglades and feeds on every level of the food chain, from small fishes to wading birds, at various stages in its life. Everglades alligators construct nests from mounds of vegetation and organic sediment that they excavate from the holes. Eggs are laid at the beginning of the wet season at elevations in the nests that are not likely to be flooded as water levels rise throughout the remaining wet season. Under current conditions, alligators have abandoned the marl prairie and Rocky Glades landscape where they were once most abundant, and where aquatic fauna were dependent on alligator holes for survival through dry seasons, because shortened hydroperiod has rendered the marl prairie and Rocky Glades a mostly terrestrial system where the alligator can no longer survive. Presently alligators and their holes are found mostly in the WCAs and Shark Slough, although reproduction is suppressed there. Water level fluctuations and impoundment effects in the WCAs and regulatory water releases into ENP thwart the alligator's ability to lay their eggs at nest elevations that will not be flooded later in the wet season. The result is an increased frequency of drowned nests under current conditions.

In the brackish-water estuarine transition between the Everglades and Florida Bay, a low-salinity mangrove fish assemblage including the sailfin molly, topminnows, sheepshead (*Archosargus probatocephalus*), rainwater killifish, and small sunfishes achieves highest densities under conditions of freshwater and salinity less than five to eight parts per thousand. Under current conditions, decreased freshwater heads and flows upstream in the Everglades frequently elevate salinity above the optima for this fish assemblage and infrequently create freshwater conditions in the estuarine transition. As a result, population densities of the small marsh fishes of the estuarine transition appear to be depressed and more erratic today in comparison to pre-drainage conditions.

The most conspicuous indicators of ecosystem health in the Everglades are the plummeting populations of wading birds, which are presently only ten percent of previous numbers of nesting birds, and which appear to continue to decline. The coastal nesting colony locations where most wood stork, white ibis and other wading bird species once nested are now abandoned. These locations are in the mangrove estuary of Florida Bay, where the juxtaposition of estuarine environments and persistent freshwater pools at the lower end of the Everglades once assured a dependable food supply throughout most breeding seasons. Particularly critical food bases include larger fishes at least in their second year of life for wood stork and a wide variety of fishes, other vertebrates and invertebrates for other species, with a particular importance of crayfish to white ibis. These food bases are mostly contained in the freshwater marsh fish assemblage of the Everglades and the low salinity mangrove fish assemblage of the estuarine transition zone that are described above.

Abandonment of the traditional coastal breeding colony locations by wading birds is largely attributed to depletion of these food bases in the southern Everglades. This depletion is due to abbreviated hydroperiods in Shark Slough and the marl prairie/Rocky Glades, the loss of drought refugia in alligator holes in these regions, and the less desirable salinity regimes in the mangrove estuarine transition. Under current conditions, most Everglades wading bird nesting colonies are located to the north in the WCAs, in areas that were not traditional colony locations. Nesting birds appear to have been drawn to the WCAs by persistent pools of water, and populations of prey species, at the lower end of each impoundment. Successful nesting there depends on the persistence of those pools, and on a steady water level recession to condense prey organisms and to provide suitable depth ranges for feeding, throughout dry seasons. Unfortunately those conditions are not predictable under current operations of the WCAs, and wading bird nesting success is low most years.

Another aspect of wading bird reproduction that is diminished under current conditions is the formation of "super colonies" of as many as 75,000 pairs of white ibis in coastal colony locations. Super colonies that traditionally nested in the coastal colonies have shifted to the WCAs, where fewer numbers of breeding pairs have uncertain and relatively low reproductive success. Super colonies recur approximately every five to ten years. They coincide with the resumption of relatively normal annual rainfall and water levels during the first year following a drought. Causal factors of super colonies are poorly understood.

Roseate spoonbills traditionally nested in eastern Florida Bay and fed upon smaller invertebrates in the low salinity coastal marshes of the Taylor Slough basin. Spoonbills have shifted colony locations to current nesting sites in central and western Florida Bay and in Big Cypress, presumably in response to declining food sources in their previous feeding grounds.

In addition to the abandoned coastal wading bird nesting colonies and depleted populations of low-salinity mangrove fishes, impacts to the mangrove estuarine transition due to diminished freshwater heads and flows upstream include degraded habitats for the American crocodile, migratory waterfowl, and nursery grounds of sport fishes and the commercially important pink shrimp (*Penaeus duorarum*). Juveniles of the endangered American crocodile seek low salinity areas of the mangrove estuary which occur less frequently today, and their survival and growth is reduced at salinity levels above 25 ppt which occur more frequently today. The winter aggregations of more than 50,000 coots (*Fulica americana*), widgeon and other waterfowl that fed on beds of Chara spp. and widgeon grass in the coastal lakes and basins no longer utilize these areas in large numbers since higher salinity has reduced the abundance of their food plants. Nursery ground suitability for juvenile sport fishes such as spotted seatrout (*Cynoscion nebulosus*), tarpon (*Megalops atlanticus*) and red drum (*Sciaenops ocellatus*) is diminished under the increased frequency of hypersaline conditions in the coastal basins. The same applies to pink shrimp in Whitewater Bay, which contribute to a multi-million annual Dry Tortugas fishery. Spotted seatrout recruitment is adversely affected at salinity levels above 25 ppt.

The white tailed deer (*Odocoileus verginianus*) is ubiquitous to most of the Everglades and the Big Cypress Basin. A healthy deer population persists in the Big Cypress Basin. In the Everglades, the deer herd currently is higher than it was under pre-drainage conditions because it has benefited from lower water levels. However, during high water periods, mortality can occur when the deer are stranded on over-browsed tree islands and starve.

Literature Cited

Florida Game and Freshwater Fish Commission 1997 Florida's Endangered Species, Threatened Species and Species of Special Concern: official lists. Florida Game and Freshwater Fish Commission, Tallahassee, FL.

U.S. Fish and Wildlife Service. 1999. Multi-species recovery plan for the threatened and endangered species of south Florida, Volume 1 of 2, The Species , Vero Beach, FL.

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Chapter 3– Natural Resource Concerns

3.1 Introduction

Consistent with the objectives outlined in Chapter 1, our primary natural resource concern for the IOP is meeting RPA requirements for the CSSS. When choices must be made amongst alternatives that meet RPA requirements, other natural resource concerns will guide our selection of a DOI preferred alternative and/or our recommendations for ways to improve the Corps' preferred alternative.

3.2 Resource Concerns

3.2.1 Cape Sable Seaside Sparrow

In assessing whether an IOP alternative will avoid jeopardizing the CSSS, the FWS must consider the regulatory definitions of "jeopardy", "adverse modification of critical habitat" and "reasonable and prudent alternatives" as well as the best scientific and commercial information currently available.

"Jeopardy", "adverse modification of critical habitat" and "reasonable and prudent alternatives" are defined by regulation (50 CFR '402.02) as follows:

> "Jeopardize the continued existence of means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species."
>
> "Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical."
>
> "Reasonable and prudent alternatives refer to alternative actions identified during formal consultation that can be implemented in a manner consistent with the intended purpose of the action, that can be implemented consistent with the scope of the Federal agency's legal authority and jurisdiction, that is economically and technologically feasible, and that the Director believes would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat."

The best scientific and commercial information on the CSSS is reviewed and analyzed in the February 19, 1999, BO and in the FWS's MSRP. A summary of this voluminous information will not be repeated here as it is readily available in the BO and MSRP, which are incorporated here by reference. Significant additional scientific information on the CSSS has become available since the BO was released and is summarized here.

3.2.1.1 Peer Review Panel Report

Subsequent to development of the BO, several interested parties raised questions regarding the validity of the scientific information on which the BO was based. A formal peer review was suggested as a way to respond to these questions and the South Florida Ecosystem Working Group's Science Coordination Team volunteered to oversee the process. An expert panel was appointed by the AOU and addressed the following six issues. Their major findings, as well as their major recommendations on each issue are reproduced below for Walters et al. (1999).

3.2.1.1.1 Conclusions from Survey Estimates

> "Given the consistency in sampling protocols between 1992 and 1998, we conclude that a true population decline is the most parsimonious explanation of the large declines in numbers counted in some sub-populations."
>
> "Having explored ways to improve survey techniques, the Panel emphasizes that we still view as parsimonious and reasonable the conclusion that sub-population A experienced a dramatic decline during the 1990s, and that eastern sub-populations C, D and F are smaller now than they were in 1981."

3.2.1.1.2 Causes of Population Changes - Flooding

> "In short, we find the evidence convincing that successful breeding in sub-population A was substantially reduced throughout the period 1993-1996 compared to earlier years, and may have been essentially nil during at least two of these years (1993 and 1995). For a small, sedentary songbird, such a significant reduction in reproductive output can be expected to result in reduction of overall population size."
>
> "The Panel views as reasonable Nott et al. (1998) conclusion that the concentrated releases of water from the S-12 structures in the years 1992-1995, above and beyond existing water depth and seasonal rainfall, directly led to the deep water conditions west of Shark Slough. These in turn probably caused habitat in the range of sub-population A to be unsuitable for breeding, and we conclude that this likely played a major role in the apparent decline of sub-population A."
>
> "Good evidence also exists that extended hydroperiods result in changes in vegetation that reduce habitat suitability for Cape Sable seaside sparrows, specifically conversion from muhly-dominated to sawgrass-dominated prairie or marsh."
>
> "Additional severe flooding in wet years clearly will put sub-population A at risk, and this risk will increase if the flooding occurs in consecutive years."

"All water management produces long hydroperiods in Area A frequently enough to alter its vegetation, as has occurred in Area D, then sparrow survival and reproductive rates will be moot. There will not be habitat to support successful reproduction regardless of how many birds might be in the area."

3.2.1.1.3 Causes of Population Changes - Fire and Woody Vegetation Invasion

"The Panel concludes that, in the short-term, loss of populations to catastrophic fire is possible but unlikely, even under current water management practices. Risk of catastrophic fire will be greatly reduced by increased flows into Northeast Shark Slough, and the potential for catastrophe increases the longer these larger flows are delayed. However, fire does have potentially important effects on population dynamics through altering habitat suitability."

"There is abundant evidence of a short-term, negative effect of burning on sparrow numbers. Burned habitat is avoided for up to a year, and numbers then increase over the next several years."

"Sub-populations C and F appear to be depressed by reduction in habitat quality resulting from fire. Abnormally high fire frequency in these areas is the direct result of reduced hydroperiods and proximity to humans."

"The aversion of the sparrows to woody vegetation in their nesting habitat, and resulting loss of habitat to invasion of woody vegetation, is well documented."

3.2.1.1.4 Causes of Population Changes - Other Hypotheses

"No direct evidence of any kind exists that muhly prairie represents sub-optimal habitat."

"The Panel encountered no evidence that the birds population is being affected by other biotic factors (e.g., unusual new predators, diseases, or competitors) or abiotic factors."

"We find Curnutt et al. (1998) arguments that Hurricane Andrew was not a primary factor in the decline of sub-population A to be reasonable. Most importantly, sub-population A continued to decline for years after Hurricane Andrew, while sub-population B received only slight less extreme wind conditions than did sub-population A, but exhibited no decline."

3.2.1.1.5 Importance of Large Sub-populations A, B and E

"It is clear, however, that the risk of extirpation is increased substantially by the reduction of the number of large populations from three to two. Therefore it is imperative not only to prevent the extinction of the third population, sub-population A, but also to promote its recovery.

3.2.1.1.6 Recolonization of Sub-populations

"No credible evidence exists that locations of large populations of Cape Sable seaside sparrows shift regularly, or that population extinction followed by recolonization is a regular process in this subspecies."

"Currently, however, relying on the existence of movement or recolonization events to compensate for ineffective management can not be justified."

"Capacity for colonization of new habitat patches probably exists. Nevertheless, the Panel sees no scientific rationale for gambling on a still unproven potential for long-distance movements as a responsible strategy for protecting the sparrow from population collapses in the few usable habitat patches that remain."

3.2.1.1.7 Management Recommendations

The Walters et al. (1999) management recommendations are reproduced here in total. Emphasized text is as in original. The "new management scheme" referred to is the Modified Water Deliveries Project.

Our primary conclusions are that,

1. Extended hydroperiods represent a serious threat to CSSS populations because they result in changes in vegetation and they suppress reproduction.

2. Changes in water management are required over the short term to prevent such extended flooding.

3. New management planned will alleviate this problem.

We note that a previous panel of scientists reached these same conclusions (Orians et al. 1996). The management recommendations below follow from these conclusions

3.2.1.1.7.1 Long-term Management

The amount of prairie habitat under protection within ENP appears to be sufficient to support a self-sustaining population of the CSSS. Indeed the total population size attained at times within this habitat, estimated at 6,000+, may be larger than that of many other populations of the species in other regions. The evidence is clear that some of the remaining habitat has been degraded in recent years by too frequent fire and extended hydroperiods, but it is also clear that the habitat can recover once these impacts are removed. The new water management scheme promises to reduce these impacts and to restore degraded habitat. From the perspective of CSSS management, we strongly endorse this new scheme, and urge that it be implemented with all possible speed. To maximize benefits to the sparrow, this plan should be implemented in such a way that hydroperiods in the prairies occupied by sparrows match historic ones as closely as possible. Once the new plan is implemented, monitoring and fire management will be the predominant management activities. Habitat loss to succession to woody vegetation must be prevented, perhaps through a prescribed burning program based on improved information about optimum burning intervals.

The natural population dynamics of the sparrow may be sufficient to fill the available, suitable habitat provided under the new water management scheme. This process promises not only to preserve the remaining large sub-populations (B and E), but also to recover the small sub-populations (A, C, D and F) to higher levels. Recovery of these currently small populations to historical levels is desirable for long-term sustainability of the CSSS. If population growth does not occur as anticipated once habitat has recovered, translocation of individuals may be necessary. Translocation is appropriate only where there is unoccupied habitat that has been restored to optimal conditions for sparrows. Currently such habitat may exist within sub-population A and perhaps at Ochopee (Kushlan et al. 1983; Nott 1998). Additional unoccupied, suitable habitat may arise as a consequence of improvements in habitat condition when the new management plan is implemented.

3.2.1.1.7.2 Short-term Management

Retaining sub-population A until the new water management plans are implemented at some unknown future date is a major concern. Our recommendations about interim management are based solely on the requirements of CSSS and ignore politics and the needs of other species inhabiting the Everglades. This approach befits the charge of the Panel. The best alternative is to reduce flows west of Shark Slough and into Taylor Slough, and increase flows into NESS, to the extent possible using existing structures. This alternative would benefit sub-populations C, D, E and F, as well as A. If this approach is not adopted, then releases of water west of Shark Slough through the S-12 structures should be closely regulated. In relatively dry years, releases could occur as they have in the past, but our recommendation for wet years is that some water normally released into ENP under existing policy instead be retained in WCA-3A. Specifically, we recommend that water be managed to enable high productivity until sub-population A has recovered to at least 1000 breeding birds. A dry period of 50-60 days, beginning 15 March, is the minimum required to ensure reasonable productivity, and a period of 80 days is preferable. A dry period of 50-60 days should allow most females to complete one brood, and a few to complete two, whereas an 80-day dry period should allow most females to complete two broods (Nott et al. 1998).

In wet years, maintaining dry conditions in sub-population A will mean retaining water in WCA-3A rather than releasing it west of Shark Slough. After sub-population A has recovered, S-12 releases could be allowed in wet years. These should not occur in consecutive years, or more often than about two years in five. It might even be possible to release water one year in five prior to recovery of sub-population A without jeopardizing recovery. Obviously such releases do not benefit the CSSS, and would have to be justified in terms of other considerations that outweigh harmful impacts on sub-population A. Similarly, each year managers will have to weigh potential increases in productivity of CSSSs resulting from extending the dry period from 60 to 80 days against the consequences of retaining water in WCA-3A. The latter will be more severe in wetter years. Evaluating the biological consequences of retaining water in WCA-3A is beyond the charge of the Panel (see Armentano 1996 and papers therein). We note that whatever adverse effects occur should be short-lived, because the need to store water in WCA-3A will cease with adoption of the new, long-term water management scheme.

Releases of water into Taylor Slough should be regulated similarly to releases west of Shark Slough to avoid extirpation of sub-population D. We conclude that extinction of sub-population D does not put the CSSS in imminent danger of extinction, but managers may prefer the actions necessary to retain it over those that will be required to restore it, should natural recolonization not occur. If retaining sub-population D is treated as a priority, then a recovery criterion based on habitat condition should be developed for that population, and releases of water into Taylor Slough should be prevented until the criterion is achieved.

That fire might be too infrequent to prevent invasion of woody vegetation is unlikely in the short term. Therefore, we recommend a policy of prevention and suppression of dry-season fires until the new management plan is in effect. We do recommend, however, that prescribed burning during the wet season be a component of this policy. If managers elect not to increase flows into NESS prior to implementation of the new management plan, then sub-populations C and F will remain at risk owing to adverse effects of fire on habitat quality. Under these conditions, we do not recommend any effort to save them other than fire suppression, nor do we recommend translocation of individuals from other populations to them. As long as abnormally frequent dry conditions continue to prevail, translocation efforts will, in our opinion, be futile. Efforts to restore sub-populations C and F, should they be extirpated, should be delayed until historic flow levels are restored to NESS. However, more aggressive management of sub-population E should be designed and implemented should monitoring indicate substantial declines in that population.

3.2.1.1.7.3 Captive Breeding

Note that we do not include captive breeding among our management recommendations. Captive breeding represents a rescue operation (Snyder et al. 1996), and the CSSS is not yet in need of rescue. The Panel views captive breeding as risky, unnecessary, premature and distracting at this time. The hope is that the management recommended is sufficient to ensure that captive breeding will never be required.

3.2.1.1.7.4 Recovery Team

Finally, we strongly recommend that a Federal recovery team be appointed for the CSSS to advise local managers. The Everglades is not a static system, and new challenges can be anticipated. A recovery team would serve as a valuable advisory group as new issues arise. Among its members should be an avian population or conservation biologist, ornithologists who have studied the CSSS, a botanist specializing in wetlands, and a hydrologist. Such a group is needed to continue the task of evaluating relevant scientific information that we have attempted here, and to assist managers in maintaining compliance with the species' recovery plan (FWS 1998).

3.2.1.2 Additional New Information

Additional new information available since release of the Walters et al. (1999) report includes the 1999 and 2000 annual reports of CSSS researchers working under Dr. Stuart Pimm. Additionaly, survey results for the 2001 survey are now available. The full 2001 annual report is not yet available. The CSSS survey estimates are provided in **Table 3.1**.

Table 3.1. The estimated number of Cape Sable seaside sparrows in each area for each year. Sparrow numbers are estimated by multiplying the actual number of birds observed by the Bass and Kushlan (1982) correction factor (x16).

Sub-population	1981	1992	1993	1994*	1995	1996	1997	1998	1999	2000 1st**	2000 2nd**	2001
A	2688	2608	432	80	240	384	272	192	400	448	400	128
B	2352	3184	2464	2224	2128	1888	2832	1808	2048	1824	2448	2128
C	432	48	0	-	0	48	48	80	144	112	64	96
D	400	112	96	-	0	80	48	48	176	64	16	32
E	672	592	320	112	352	208	832	912	768	1040	704	848
F	112	32	0	-	0	16	16	16	16	0	112	32
Total	6656	6576	3312	2416*	2720	2624	4048	3056	3552	3488	3744	3264

* 1994 surveys were incomplete due to logistical problems.
** In response to peer review recommendations, two separate surveys were conducted in 2000.

The 1999 and 2000 annual reports also include draft papers exploring the CSSS's extinction risk, detailing the results of intensive observation and tracking of breeding success and other life history variables in several study plots, and detailing efforts to define the CSSS's nesting microhabitat preferences. One of these papers, entitled *Range-wide risks to large populations: The Cape Sable seaside sparrow as a case history*, (Pimm and Bass, pers. comm.) was recently accepted for publication.

Pimm and Bass (pers. comm.) model CSSS populations under different water and fire management scenarios. Their modeling predicts that the CSSS's western sub-population will decline to extinction when water is managed as is was over the 1977-1997 period, and that the western sub-population would persist if water releases into this area that would inhibit reproduction were prevented. Their analysis also suggests that the other CSSS sub-populations are at risk of extirpation due to high fire frequencies. Pimm and Bass (pers. comm.) conclude "The Cape Sable seaside sparrow will only survive if it has at least three healthy populations. To implement this requirement, the breeding areas west of Shark Slough must not be flooded in the breeding season and water levels should be raised in NESS to reduce the incidence of fires there."

3.2.2 Tree Islands

Within the freshwater, brackish and saline wetlands of the Everglades region, small forested communities occur as discrete units in the landscape. Some general aspects of tree islands have been introduced in Chapter 2. Everglades tree islands typically are associated with specific substrates, such as limestone outcrops or peat, and comprised of plant and animal species that differ from the surrounding wetlands. The tree islands function as reservoirs of species diversity and as habitat for numerous species of wildlife and plants that otherwise would be absent from the wetlands. Thus collectively, these communities, although comprising less than 10% of the wetlands area, serve functions that are valued in restoration.

The chief threats to tree islands are fires , especially those which consume organic substrates, invasion by exotic plants, and hydrological extremes, particularly when they follow fires. In WCA-2A and portions of WCA-3A, in what has been the most destructive scenario, burn-out of peat has lowered tree island elevation, rendering islands susceptible to high water stress. Tree mortality occurred although the most flood tolerant species like *Annona glabra* have survived, and the substrate, with its capacity to serve as a seedbed for new tree recruitment, persists unless the substrate is completely burned-out. Note, however, that although inundation of tree islands in Shark Slough has occurred over months, investigations have not found ecologically significant impacts of high water levels such as has been reported for the impoundment areas of the WCAs. This difference may underscore the importance of surface water flows to tree island sustainability.

No measure of tree island biological response or physical condition can so far be linked directly to water management operations and the depth of water in the surrounding marsh forms the basis for the performance measure used in this assessment- the duration during which marsh water levels exceed 2.5 feet. The rationale for this depth was introduced in Chapter 1. The selected depth is best viewed as a "yardstick" that relates in some way (perhaps only statistically rather than functionally) to conditions that lead to flooding stress in tree island communities. As noted, effects of a given water depth depend on biological and physical variables that often have not been measured. Some tree islands will be unaffected even by extended depths exceeding 2.5 feet in the marsh either because of the height of the outcrop on which the tree island grows above the surrounding marsh or because of the adaptations to flooded soils of the constituent species.

At the other hydrological extreme, drawdowns of water levels increase fire vulnerability and promote oxidation of organic substrates, especially when water levels fall below the ground surface for long periods. In fact, the complete destruction of tree islands by fires during droughts (exacerbated by the artificial diversion of water out of marshes) has occurred both north and south of Tamiami Trail. Despite the importance of fire effects, however, there is little quantitative data on fire vulnerability, fire effects and the extent to which they are promoted by water table withdrawals and droughts. However, the positive correlation between increasingly deep water table depths below the ground surface and fire risk serves as a basis for the previously described performance measures.

3.2.3 Snail Kite Habitat

The Florida snail kite population is considered to function as a single population with considerable shifts in distribution in response to changing hydrologic conditions (Bennetts and Kitchens 1997). The snail kite's Florida range is restricted to the Kissimmee, Okeechobee, Upper St. John's River and Everglades basins, and a majority of this area has been designated as critical habitat for this species. This restricted range, combined with the snail kite's highly specific diet composed almost exclusively of apple snails, makes the snail kite's survival and breeding success highly dependent on hydrologic conditions in these areas. Particularly under drought conditions, suitable conditions must be available in at least one of these four areas in order to support sufficient reproductive output to maintain population numbers (FWS 1999). When drought effects all four areas, population numbers would be expected to crash, although additional research on survival following drought periods is needed to confirm this.

Nesting snail kites use wetlands with multi-year inundation periods ranging from approximately 80 – 99% of the period. Foraging snail kites use wetlands having inundation periods as low as 70% during the non-breeding season (Bennetts and Kitchens 1997). Longer inundation durations have been documented to result in losses of woody vegetation which are used as nesting substrate and for roosting and foraging perches. Continuous flooding also kills sawgrass and other emergent graminoid vegetation that provides substrate for apple snails at heights close enough to the water surface to be available to foraging kites. Frequent drying events may also render habitats unsuitable for snail kite foraging due to reduced survival and availability of apple snails. Impacts to apple snail populations would be particularly severe during drying events lasting longer than the four week average drought survival time for apple snails, and for drying events occurring during the January – May peak of apple snail egg-laying.

Snail kite use of the study area fluctuates greatly, with low use during drought years, such as 1991, and high use in wet years, such as 1994. Although sharp declines have occurred in the counts since 1969 (for example, 1981, 1985, 1987), it is unknown whether decreases in snail kite numbers in the annual count are due to mortality, dispersal (into areas not counted), decreased productivity, or a combination of these factors. Despite these problems in interpreting the annual counts, the data since 1969 have indicated a generally increasing trend (Bennetts et al. 1994). However, the degree of this apparent increase in the snail kite's population needs to be confirmed with alternative methods of estimating population size.

3.2.4 Wading Bird Nesting Success

As described above, altered hydrology in the greater Everglades basin is thought to be the main cause of dramatic declines in wading bird numbers and nesting success since the early 20th century. Recent wading bird nesting effort has shifted away from historic colony locations along the Florida Bay and Shark Slough mangrove fringe to colony sites in and around the WCAs. Nesting success is poor in most years even in these new locations, primarily due to frequent drying events that suppress prey fish populations and biomass and to reversals in dry season recession rates that reduce concentrations of fish necessary for peak wading bird foraging efficiency. Loss of woody vegetation used as nesting substrate can also occur during extreme high water events. Impacts to wading bird nesting success resulting from IOP operations can be minimized by reducing the frequency and severity of drying events, reducing the occurrence of dry season water level reversals and minimizing the frequency and duration of extreme high water events.

Wood stork nesting success is of particular concern because of the endangered status of the species. Historically, south Florida supported greater than 70 percent of the total wood stork nesting effort in the southeast U.S. In 1996, nesting effort in south Florida improved from the previous three years, most likely in response to improved foraging conditions as a result of a rapid drydown following three high water years. In ENP, Big Cypress National Preserve, Corkscrew National Sanctuary, and Florida Panther National Wildlife Refuge, there were a total of approximately 1,600 nesting pairs. Numbers of nesting storks in the action area have declined from 1996 to 1999, and now average about 142 nesting pairs (Ogden, pers. comm., 1998). Ogden (1998) defines a set of measures that can be used to evaluate the effects of alternative water management scenarios on the timing of wood stork colony formation. These measures are the duration and timing of hydroperiods in two areas of Shark Slough known as Indicator Regions (IR) 10 and 11 and the volume and timing of water passing through the southern portions of Shark Slough and Taylor Slough. Each of these measures provides information on the amount and timing of freshwater reaching the mangrove zone nesting habitat, which, in turn, provides information on when conditions conducive to wood stork colony formation would be expected under various water management scenarios. Some insight into impacts to wood storks in the WCAs can be evaluated through an examination of expected effects on tree island habitats that provide nesting and roosting substrates.

3.2.5 Shark Slough

Shark Slough is the main drainage of the Everglades that connected Lake Okeechobee to the southern estuaries prior to human intervention. The remaining system, now reduced to about half of its area also has, south of Tamiami Trail, experienced reductions in hydroperiod, water depths, distribution, timing and reductions in sheet flow. Effects are most notable in NESS, where inflows have been reduced to seepage and culvert flow due to enclosure on three sides by canal and levee structures North of Tamiami Trail, changes have been severe and include deep multi-year ponding with negligible flow in southern WCA-3A , complete interruption of sheet flow in WCA-3B and over-drainage in the northern portions of WCA-3A and WCA-2. In all these areas, the slough communities have responded, shifting away from the distribution of natural communities that established an equilibrium with the natural hydrological regime and accumulated peat in the millennia prior to the water management era. South of Tamiami Trail, aquatic slough community that formed Loxahatchee peat in the millennia prior to the water management area yielded to a mix of communities reflecting drier conditions with predominance by sawgrass. In the WCAs, the interruption of surface water flows has led to a degradation of the Ridge-and-Slough landscape that characterized the slough at large scales, as well as to major shifts in communities, in response to either much wetter or much drier conditions, depending on location. In addition, the shallower water and shorter hydroperiods of NESS, WCA-3B, and WCA-2, have permitted the establishment of Melaleuca, a highly invasive exotic wetland tree from Australia that has replaced native wetland communities with dense single species "monocultures".

The capacity of the altered sloughs for supporting native animal communities has been much reduced. Unnatural interruptions in surface flooding, shallower depths, longer and deeper dry-downs and artificial manipulation of the timing and distribution of surface water flows has reduced alligator, fish and invertebrate productivity, as well as the capacity of the wetlands to support predatory species such as wading birds, and alligators.

Since aquatic slough communities require long periods of flooding by relatively deep water, performance measures are based on the annual duration of uninterrupted hydroperiod and the duration of uninterrupted hydroperiod at water depths greater than one foot. Under natural conditions, continuous flooding occurred year-round in average and wetter than average years. At this flooding level, net peat accretion can occur. Although fires occurred naturally in sloughs during droughts, their frequency and intensity were insufficient to cause a net loss of peat except locally for short-term intervals. More research is needed, but some information available suggests that much of Shark Slough may not be accumulating peat on a net basis in the modern system, a situation attributable to the altered hydrological budget in the Everglades. Performance measures which reflect the prolonged deep inundation that supported the aquatic slough ecosystem have been developed across all of the historic Shark Slough within the study area, reflecting the regional scale conditions that prevailed before compartmentalization and drainage. These include continuous hydroperiods above 1.0 and 1.5 feet, the annual minimum surface water level and the durations of time below the ground surface.

3.2.6 Rocky Glades and Eastern Marl Prairies

This area constitutes the higher wetlands east of Shark Slough and west of the Atlantic Coastal Ridge. It is an area with the limestone substrate at or near the ground surface and a karst landscape with many solution holes. In the past, the area served many vital functions associated with its hydrological connection to Shark Slough and Taylor Slough. These functions include serving as the headwaters for Taylor Slough, providing vital foraging area for wading birds during early and mid-dry season when the sloughs are too deep, habitat for alligators, support of a biologically diverse marl prairie plant and animal community, and providing dry season refugia for aquatic animals. However, the area has been highly altered by water management actions, particularly drainage and seepage loss connected to the L-31N and L-31W canals along the eastern ENP boundary and by distortions of the natural spatial distribution surface water flows in Shark Slough flows. The close proximity of this area to the eastern protective levee and canal system makes it especially vulnerable to both rapid increases and decreases in pumping of inflows and the lowering of canal water levels which reduce secondary productivity at all levels of the marsh tropic web.

In recent decades, the overall effect of the water management manipulations in this area has been a general collapse of ecosystem function including the near total loss of alligators, a severe curtailing of the ability of the area to support aquatic animal production and a sharp decline in the use of the area by wading birds. In addition, aggressive colonization by exotic plants and by exotic fish has degraded much of the areas while native woody species have spread into the marshes in response to the lowered water levels.

Year-round water table elevations are a critical aspect of ecosystem function in the Rocky Glades marshes. In the rainy season the key parameter is the presence of surface water at depths and for durations that support aquatic animal productivity. In the dry season, when surface water is lost, the depth of groundwater becomes important because it determines the extent to which the abundant solution holes retain water, thus sustaining the aquatic animals until the return of surface water. One performance measure, therefore, compares the duration of flooding to a depth of at least 6 inches (~15 cm), the minimum depth allowing small fish to use the marsh. A second is the minimum depth reached by ground water levels in the dry season, which governs the proportion of solution holes that function as refugia until the advent of the rainy season. A third aspect relates to the damaging impact of drawdowns of marsh water below the critical minimum depths above and below the ground surface. As discussed in Chapter 2, rapid and severe drawdowns can strand fish on the surface before they reach solution hole refugia or even dry out shallower refugia, killing the animals within. The applicable third performance measure, then, is the number of these water level reversals, with the lowest frequency being the best.

3.2.7 Florida Bay

The chief inflows of freshwater into northern Florida Bay can be traced back to freshwater flows in Taylor Slough that reach the Bay via numerous small creeks that traverse the mangroves that fringe the Bay. In addition northeastern Florida Bay (including the northern embayments such as Joe Bay and Long Sound) receives freshwater from the C-111 canal which discharges into the panhandle region of ENP. The northern part of the Bay, and its embayments, typically experience salinity fluctuations ranging from brackish (5-10 ppt) to near marine concentrations (30-35 ppt). However, heavy rains and droughts can force the extreme salinities to from 0 to 50 ppt or more. Effects of inflows in central Florida Bay are attenuated and salinities are influenced more by rainfall fluctuations. Because western Florida Bay is dominated by Gulf of Mexico, terrestrial runoff has relatively little effect on salinity although near-shore flows around Cape Sable which are freshened by the Gulf Coast rivers that drain Shark Slough contribute to an annual salinity cycle there. Upstream water management operations have the effects of altering the annual salinity cycle by reducing inflows, driving up mean salinities and by diminishing the lag flows that limit salinity increases in the early part of the dry season. As a result Florida Bay is less suitable as a nursery area for important species such as sea trout, snook, tarpon and pink shrimp. Water management actions also have increased salinities in Whitewater Bay, reducing its effectiveness in supporting growth and survival of pink shrimp and several important fish species.

Both water levels and salinity factors fundamentally control the distribution and productivity of aquatic plants (seagrasses in the more marine areas and submerged aquatic marsh species in the downstream marshes) and of the fish and other aquatic animals that use vegetated areas as habitat. Recent research has shown how the productivity of the plants and animals has declined in response to the reduced flows and higher salinities brought about by alteration of the natural hydrological regime. Declines in nesting and foraging of wading birds such as the roseate spoonbill and other consumers that depend on the organisms inhabiting the coastal marshes and adjacent marine waters are reported to have occurred. In addition, the endangered American crocodile, has shifted its range out of its historic nesting area along the shore of northeast Florida Bay. Evidence suggests that this may be due to reduction of the abundance of prey species and to the relatively high salinities that are harmful to immature crocodiles (FWS 1999). The American crocodile populations in south Florida has increased substantially over the past 20 years. P. Moler (GFC, pers. comm., 1998) believes between 500 and 1,000 individuals (including hatchlings) persist there currently. The recent increase is best represented as changes in nesting effort. Survey data gathered with consistent effort indicates that nesting has increased from about 20 nests in the late 1970's to about 50 nests in 1997. Since it is likely that female crocodiles only produce one clutch per year it follows that the population of reproductively active females has more than doubled in the last 20 years.

The endangered West Indian manatee may also be affected by changes in Florida Bay hydrology. Manatees occur in both fresh and salt water habitats within tropical and subtropical regions and show preferences to waters with salinity levels of < 25 ppt (Hartman 1974). In south Florida, manatees are most prominent year round in the Indian River, Biscayne Bay, Cape Sable and Ten Thousand Islands, Estero Bay and Caloosahatchee River, and the Charlotte Harbor area. Several factors contribute to the distribution of manatees in Florida. These factors are habitat-related and include proximity to warm water during cold weather, aquatic vegetation availability, proximity to channels of at least 6.5 feet in depth, and location of freshwater sources (Hartman 1974). Use of much of Florida Bay by manatees is infrequent, probably due to higher salinities and lower water depths in much of the Bay.

Possible effects on manatee habitats resulting from IOP alternatives can be evaluated through examination of patterns and volumes of freshwater flows reaching their Shark Slough and Florida Bay estuary habitats. Significant decreases in freshwater flows and/or significant changes in the timing of flows may reduce habitat quality. Increased freshwater flows consistent with natural seasonal patterns may improve habitat quality for manatees.

3.2.8 Water Quality

The physical and chemical quality of surface water flows into ENP are governed by two sets of standards or criterion set by state and federal agencies. The surface waters of ENP have been designated Class III waters by the Florida Department of Environmental Protection (FDEP). Surface waters are classified according to their designated use. According to the Florida Administrative Code (Chapter 62-302.400, F.A.C.), Class III waters are for: "Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife." Chapter 62-302.530 F.A.C. contains a table that lists the constituents of surface water with either a numeric or narrative criteria for each based on the various classes. This chapter contains the nutrient criteria for all classes of waters that is in the form of a narrative: "In no case shall nutrient concentrations of a water body of be altered so as to cause an imbalance of natural populations of aquatic flora or fauna." At this time, there is ongoing research and evaluation by the State of Florida (FDEP and the SFWMD) and the Federal Government (Environmental Protection Agency (EPA) and the DOI) to determine the Class III numerical phosphorus criterion for Everglades wetlands.

Some water bodies in the State of Florida have been designated Outstanding Florida Waters (OFW) (Chapter 62-302.700). The State of Florida (specifically FDEP) gives added protection to these waterbodies such that no degradation of water quality is allowed in terms of the existing ambient water quality that existed from the last day of the baseline year. The baseline year is defined as the year in which the waterbody was designated as an OFW. The waters of ENP were designated as an OFW on March 1, 1979. OFW water quality criteria for the various constituents of ENP waters have never officially been designated. The Modified Consent Decree (MCD) (Case No. 88-1886-CIV-HOEVELER) attempted to define the phosphorus criterion for the waters in ENP because of the unreliability of total phosphorus data from the baseline year.

The MCD divides the waters of ENP into two sets of basins, Shark Slough and the Taylor Slough/Coastal Basin. The MCD sets interim and long-term limits for Shark Slough and long-term limits for Taylor Slough/Coastal Basins. The long-term concentration limit for Taylor Slough/Coastal Basins is 11 ppb and must be met by December 31, 2006. The MCD states that the long-term limits are the limits necessary to meet the OFW water quality criteria as measured at the structures discharging into ENP. It is hoped that these criteria will prevent an imbalance of natural flora or fauna. Compliance with the long-term concentration limit of 11 ppb is expected to produce a long-term average flow-weighted mean inflow concentration of 6 ppb for the Taylor Slough/Coastal Basins. Compliance with the interim and long-term limits for the Shark Slough Basin is expected to produce a long-term average flow-weighted mean inflow concentration of 8 ppb.

The original MCD required that Taylor Slough compliance be measured at S-332 and S-175 and the Coastal basin at S-18C. However, S-332D has been constructed north of the Frog Pond in the L-31W canal and S-332B has been constructed in L-31N, just south of S-173. The Technical Oversight Committee has recommended that S-332D be used in place of S-332 and S-175 when it begins operation. FDEP has not issued an operating permit for these structures for numerous reasons among which are water quality concerns. However, the Corps in response to the FWS's RPA for the CSSS contained in the February 19, 1999, BO has been temporarily operating these structures.

In May 1999, the EPA accepted 0.010 mg/L or 10 ppb as the total phosphorus water quality threshold criterion for some of the Miccosukee Tribe of Indians of Florida lands within the Everglades. EPA stated that this standard was a "scientifically defensible value which is not overly protective" and this value would protect the designated use of this area which was for the "preservation of native plants and animals." Dr. Ron Jones (pers. comm.) is finding similar results in his flume dosing study in Shark Slough within ENP- total phosphorus concentrations above 10 ppb causes significant changes to the periphyton mat. Thus surface water discharges into ENP with total phosphorus concentrations consistently greater than 10 ppb probably will damage Park resources.

The Corps proposes to divert Shark Slough flows into Taylor Slough (S-332B and S-332D) and the Coastal Basin (S-18C). Shark Slough water originates in the Everglades Agriculture Area. The State of Florida, as represented by the SFWMD, has designed and partially constructed over 40,000 acres of Stormwater Treatment Areas (STA) at a cost of almost $1 billion to reduce phosphorus levels in the Everglades Agriculture Area discharges to the Everglades. In addition, prior to entering ENP, Shark Slough water sheet flows through the marshes of WCA-3A. By the time Shark Slough flows reach ENP inflow points most phosphorus has been incorporated into the sediments or into biomass. Some of the ISOP and IOP alternatives propose to move this water out of the Everglades, closer to the Miami-Dade urban area, adjacent to the 8.5 Square Mile Area, and through the South Dade Agriculture Area before discharging it back into the Everglades. There are no water quality treatment areas, existing or proposed, adjacent to the structures (S-332B, S-332D or S-18C) that will be discharging this water back into ENP. In the MCD the expected long-term average flow-weighted mean inflow concentration for the Taylor Slough/Coastal Basins is lower (6 ppb) than it is for Shark Slough Basin (8 ppb).

During the interim operation, there was no water quality treatment system for the C-111 and Coastal basin flows into the Rocky Glades. IOP alternatives that divert Shark Slough waters out of the Everglades and back into this area will have increased phosphorus loads and therefore are less marsh ready; potentially resulting in greater water quality impacts in the future. The performance of the IOP alternatives can be ranked based on the projected phosphorus loads discharged into the Rocky Glades from S-332B and S-332D.

The phosphorus loads in kilograms of phosphorus were calculated for S-332B by using the mean phosphorus concentration (in mg/L) from the Corps' preliminary water quality data for January and March 2000 at the automatic sampler in L-31N downstream of S-331. The phosphorus load for S-332D was calculated using the mean concentration of phosphorus from the Corps' preliminary water quality data for January and March 2000 at the automatic sampler upstream of S-332D. Flow in acre-feet for each alternative was obtained from the discharge figure for each structure with a return period of 2 years. Phosphorus load for each structure is the product of the mean phosphorous concentration for that structure times the projected discharge for that structure in acre-feet multiplied by 1.234. Phosphorus loads into the Rocky Glades is the sum of the load discharged from S-332B and S-332D. Because this water is untreated a lower phosphorus load is better.

Phosphorus loads were also calculated for southern Shark Slough from the S-12 discharges and NESS from the S-333 and S-334 discharges in much the same way. Since there was no Corps water quality data for these structures, SFWMD's grab sample data was used from January and March 2000 (Bechtel, pers. comm.). The mean phosphorus concentration was computed for each structure and then used to determine the phosphorus load in the manner discussed previously. The flow into NESS is the result of S-333 discharge minus S-334 discharge for each alternative. Phosphorus load discharges into NESS and southern Shark Slough are marsh ready and therefore higher load is equal to better alternative performance.

Looking at the preliminary Corps' groundwater and surface water quality data discharges from S-332B, S-332D, and S-18C, if left untreated, will likely exceed the flow-weighted mean concentration phosphorus limit specified in the MCD. As a performance measure, the IOP alternatives can be ranked based on the increase in discharges from these three structures under the Rocky Glades spreadsheet.

When peat soils oxidize either by drying out or burning, phosphorus changes to an inorganic form that is more biologically available. This generally happens during the dry season. During the subsequent wet season, these areas flood and this phosphorus is incorporated into the water column. This material is then transported to downstream marshes when water elevations reach discharge levels for the various structures between the WCAs and ENP. A performance measure can be based on the assumption that greater frequency of dryouts in the WCAs will increase the phosphorus loads entering ENP. The ISOP alternatives will be ranked on how they affect 30-day dryouts in WCA-2A, WCA-3A, and WCA-3B which will determine future phosphorus loads discharged into ENP.

Literature Cited

Bennetts, R.E., M.W. Collopy and J.A. Rodgers. 1994. The Snail Kite in Florida in the Florida Everglades: a food specialist in a changing environment. Pp. 507-532 in S. M. Davis and J.C. Ogden (eds.). Everglades: the ecosystem and its restoration, St Lucie Press, Delray Beach.

Bennetts, R. E. and W. Kithches 1997. The Demography and Movements of Snail Kites in Florida. Tech. Rpt. No. 56, U.S. Geol. Survey/Biol. Res. Div., Florida Cooperative Fish & Wildlife Unit, Gainesville, Fl.

Curnutt, J. L., A. L. Mayer, T. M. Brooks, L. Manne, O. L. Bass Jr., D. M. Fleming, M.P. Nott and S. L. Pimm. 1998. Population dynamics of the endangered Cape Sable seaside-sparrow. Animal Conservation 1:11-21

Hartman D.S., 1974. Distribution, status, conservation o f the manatee in the United States. Technical Report NTIS PB81-140725, Report to U.S. Fish and Wildlife Service, National Fish and Wildlife Lab, 1974. 247 pages.

Kushlan, J. A. and O. L. Bass Jr. 1983. Habitat use and the distribution of the Cape Sable sparrow. Pp. 139-146 *in* The Seaside Sparrow, its biology and management (T. L. Quay, J. B. Funderburg, Jr., D. S. Lee, E. F. Potter, and C. S. Robbins, eds.). Occas. Pap. North Carolina Biol. Surv., Raleigh, NC.

Nott, M.P., O.L. Bass Jr., D.M. Fleming , S.E. Killeffer, N. Frahley, L. Manne, J. L. Curnutt, T.M. Brooks, R. Powell, and S.L. Pimm. 1998. Water levels, rapid vegetation changes, and the endangered Cape Sable seaside sparrow. Animal Conservation. 1(1):23-32.

Ogden, J.C. 1998. Endangered species performance measures (wood stork). Document prepared as part of the Southern Everglades Restoration Alliance planning process, South Florida Water Management District, West Palm Beach, FL.

Orians, G. H. 1996. Report of the Panel to Evaluate the Ecological Assessment of the 1994-95 High Water Levels in the Southern Everglades, Appendix to Armentano, T. V. 1996 (ed.). Ecological Assessment of the `994-95 High Water Conditions in the Southern Everglades. Proceedings of the Conference held at Florida International University, August 1996. Held under auspices of Science Sub-Group, South Florida Management and Coordination Working Group.

Pimm, S. 1999, Cape Sable Seaside Sparrow Annual Report: 1999. Unpublished report provided to FWS

Pimm, S. 2000, Cape Sable Seaside Sparrow Annual Report: 2000. Unpublished report provided to FWS

Snyder, N.F.R., S.R. Derrickson, S.R. Beissinger, J.W. Wiley, T.B. Smith, W.D. Toone and B. Miller. 1996. Limitations of captive breeding in endangered species recovery. Conservation Biology 10:338-348

U.S. Fish and Wildlife Service. 1998a. Multi-species recovery plan for the threatened and endangered species of south Florida, Volume 1 of 2, The Species. , Vero Beach, FL.

U.S. Fish and Wildlife Service. 1999. Multi-species recovery plan for the threatened and endangered species of south Florida, Volume 1 of 2, The Species. , Vero Beach, FL.

Walters, J.R., S.R. Beissinger, J.W. Fitzpatrick, R. Greenberg, J.D. Nichols, H.R. Pulliam and D.W. Winkler. 1999. Cape Sable Seaside Sparrow Panel Review: Final Report. Miami, FL.

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Chapter 4-Alternative Description

4.1 Introduction

Before beginning the hydrologic and ecological analysis it will be useful to provide a thorough narrative description for each of the alternatives simulated. The following section includes narrative explanations and generalized graphical summaries of the expected hydrologic consequences should an alternative be implemented. Section 4.4 contains a review of the South Florida Water Management Model (SFWMM) output relative to other models. This section provides insight into the applicability of the SFWMM for the intended purposes with respect to the operation of S-332B and the simulation of the detention reservoir. The section is followed by the hydrologic changes resulting from the implementation of the ISOP operational criteria for S-332B. The final section provides an ecological examination of potential consequences.

4.2 Alternative Descriptions

The success in meeting the requirements of the BO and thus avoiding jeopardy to the continued existence of the CSSS, relies heavily on the water management operations of the C&SF Project. The BO describes the RPAs determined by the FWS to achieve this objective. The long-term solution selected by the Corps and accepted by the FWS and NPS is the implementation of a Modified Rainfall-Driven alternative in the MWD project. However, until the completion and implementation of the MWD project in 2003, an IOP is necessary. The IOP must be consistent with the RPA or at least the hydrologic equivalent in the CSSS habitat, to replace the Experimental Water Delivery criteria. This section provides narrative and graphical descriptions for each of the base conditions, the RPA and the proposed alternatives simulated by the SFWMM (MacVicar et al. 1984; SFWMD 1997) in pursuit of a suitable IOP.

Operations under the RPA or ISOP/IOP are intended to curtail water management operations that may negatively affect the CSSS. Sub-populations of the CSSS have been adversely impacted directly by water management operations during their breeding season and indirectly through vegetation shifts across their native habitats. Water management operations linked to unfavorable hydrologic regimes for a naturally dynamic CSSS population include:

- Voluminous S-12 discharges that raise water levels in CSSS habitat.
- Temporal and spatial distribution of surface flows to Shark Slough that cause CSSS habitat to be too wet or too dry.
- Water management operations associated with the L-31N and C-111 canals that can dry out CSSS habitat through low canal stages relative to the adjacent marsh.

4.2.1 The RPA (RPA02)

Specific operational criteria for structures most likely to affect the hydrology across each of the

CSSS sub-population habitats and other natural areas is shown in **Table 4.1**. A brief narrative of the operations of the RPA and its associated benefits follows. The foundation of the RPA is the redistribution of Shark Slough flows to resemble conditions during the pre-water management hydrologic regime **(Figure 4.1)**. As the spatial extent of flows is increased along the cross-section of Shark Slough, the RPA re-establishes the temporal connection with observed rainfall. A second and key element of the plan is to increase the operational criteria along the L-31N and L-31W canals to Test 7 Phase II levels. At the same time, the RPA attempts to shift a portion of the large regulatory S-12 flows into the historical receiving basin, NESS. Operational stages in the L-31N and L-31W canals are intended to minimize seepage from the natural areas of ENP and to attenuate water management actions on peak water levels for ecological benefits later in the dry season, while providing the authorized levels of flood protection.

In the model runs of the RPA, flows to NESS, during both the wet and dry seasons, are constrained by the limitation of S-333 design capacity (1350 cfs), and the 9.0 feet maximum stage in L-29, and the stage at G-3273. The criteria are applied as follows. If stage at G-3273 is less than 6.8 feet, S-333 flows are limited by the design capacity of the structure or the L-29 stage constraint. If stage at G-3273 is greater than 6.8 feet, then up to 60% of the WCA-3A regulatory flows must be passed by S-333. Specific operations for western Shark Slough relative to CSSS sub-population A include: deviation to the WCA-3A regulation schedule, and early closure of the S-12's, S-343, and S-344 structures. The S-343 and S-344 structures are closed November 1 through July 15 independent of WCA-3A stages. A tiered closure of the S-12's starts with S-12A closing on November 1st, S-12B on January 1st, and finally S-12C on February 1st. All of these structures will remain closed through July 15th.

To mitigate for the effects of the closure of the S-12, S-343, and S-344 structures, a deviation to the WCA-3A regulation schedule was established by the Corps. Although not specifically stated as such in documentation, the first objective of the deviation is to provide additional storage during periods when the S-333 criteria preclude inflows to NESS. The ancillary benefit from this action is that allowing surface water flows to NESS coincident with the period of peak annual stages will enhance hydrologic conditions for the eastern CSSS sub-populations. At the same time, the deviation utilizes additional outlet capacity in an attempt to forestall the undesirable excessively deep and long duration inundation observed with earlier iterations of the IOP process and attributed to the deviation schedule. Unfortunately, the only available outlet capacity is to tide via the Miami Canal (C-6).

Along the eastern boundary of ENP, Test 7 Phase II stages are maintained. These stages provide improved hydroperiods in the Rocky Glades while maintaining authorized levels of flood protection (Corps 1997). Although increased inflows associated with S-333 operations are a part of the RPA, no changes to the operational criteria above G-211 and S-338 were implemented. Ideally, given the introduction of these flows, increases to the operational criteria could be warranted to limit seepage from NESS. With respect to the S-331 pump station, the RPA maintains the operations under Test 7. Downstream of S-331 the operational criteria along the L-31N canal increase to Test 7 Phase II levels. Although these criteria still remain well below their originally authorized levels a reduction of seepage could still be anticipated resulting in hydrologic benefits to the eastern CSSS sub-population habitats.

Table 4.1. Summary of operational criteria for RPA02 simulation.

	RPA02
Regulation Schedule	Deviation schedule for WCA- 3A as specified by USACE including raising Zone D to Zone C from Nov 1 to Feb 11. No deviation in WCA- 2A regulation schedule.
S-343 A/B and S-344	Closed Nov 1 to July 15 independent of WCA-3A levels.
S-12 A/B/C/D	S- 12A closed Nov 1 to Jul 15; S- 12B closed Jan 1 to Jul 15; S- 12 C closed Feb 1 to Jul 15; S- 12D was operated normally according to WCA- 3A schedule. For the remainder of the year, S- 12A, B, and C followed the same schedule.
S-333: G-3273 < 6.8'	55% of the rainfall plan target to NESRS, plus as much of the remaining 45% that the S- 12s can't discharge to be passed through S- 334; and subject to capacity constraints, which are 1350 cfs at S- 333, L- 29 maximum stage limit, and canal stage limitsdownstream of S- 334.
S-333: G-3273 > 6.8'	Pass 60% of regulatory discharge through S- 333 subject to S- 333 design capacity (1350 cfs)
L-29 constraint	9.0 ft
S-355A&B	Regulatory releases are constrained by L- 29 and G- 3273 triggers. Dry Wet Open 8.50 8.50 Close 6.50 6.50
S-337	Water supply only
S-151	Per the above WCA- 3A regulation schedule.
S-335	Open at 7.5; Close at 7.2
S-334	Water supply only
S-338	Open at 5.8; Close at 5.5.
G-211	Open at 6.0; Close at 5.5.
S-331	Start pump at 4.8; pump down to 4.3.
S-332B	Pump up to 325 cfs. Dry Wet On 5.00 5.00 Off 4..80 4.80
S-332B Seepage Reservoir	160 acres with emergency overflow.
S-332D	Pumped up to 500 cfs design capacity from Aug 1 to Jan 31 and to 165 cfs from Feb 1 to Jul 31. Dry Wet On 5.00 5.00 Off 4.80 4. 80
S-332	Closed
S-175	Closed
S-194	Dry Wet Open 5.30 5.30 Close 4.80 4.80
S-196	Dry Wet Open 5.30 5.30 Close 4.80 4.80
S-176	Dry Wet Open 5.20 5.20 Close 5.00 5.00
S-177	Open at 4.2; Close at 3.6
S-18C	Dry Wet Open 2.60 2.60 Close 2.30 2.30
S-197	Same as Test 7 Phase I; Close at 2.3

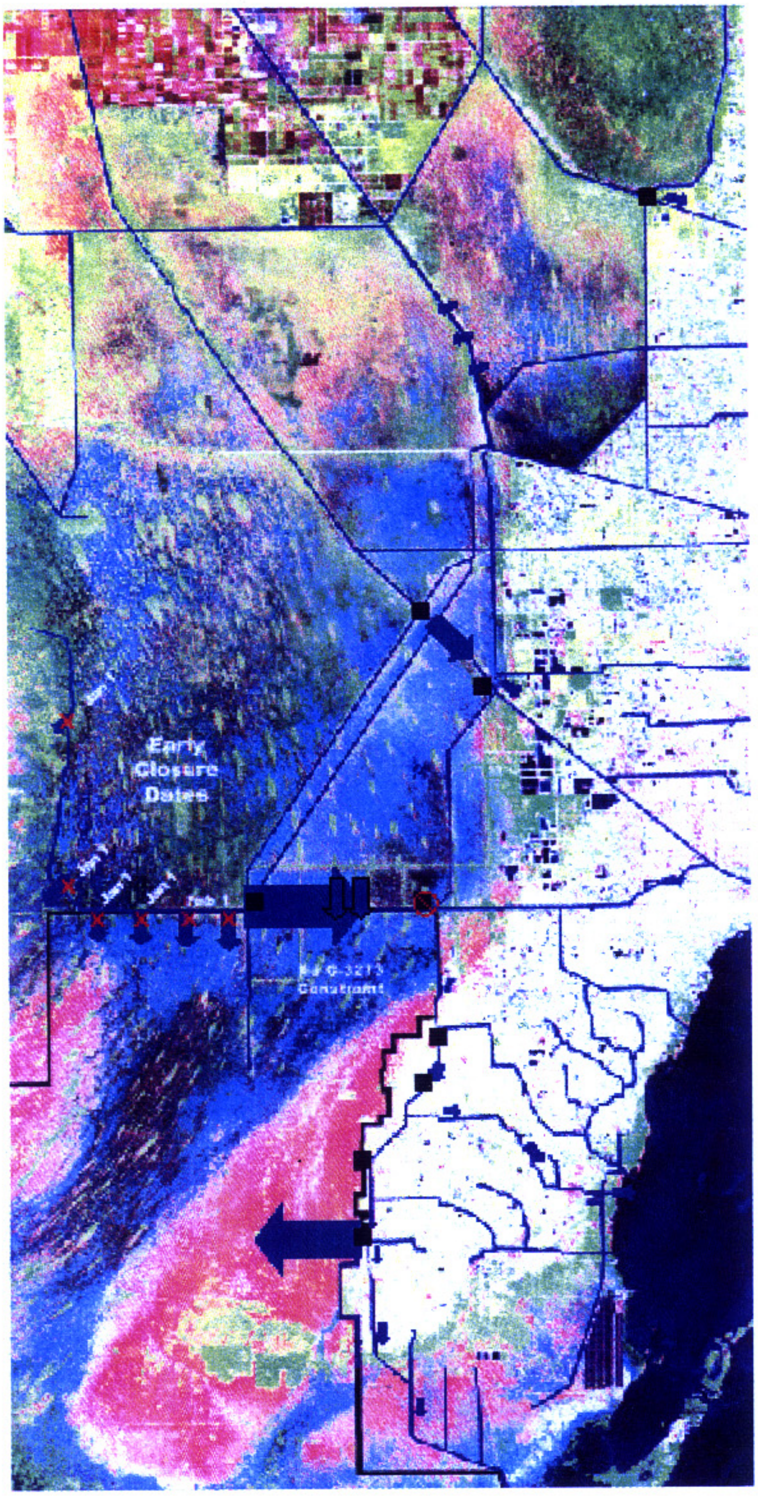


Figure 4.1. Conceptual diagram of operations and flow redistribution under RPA02 relative to Test 7 Phase I.

An important component of the RPA affecting the Taylor Slough basin is the removal of the stage constraint in the L-31W canal. The removal of this constraint in combination with the end of S-332 pumping and closure of S-175 is considered a major step in allowing peak annual water levels to respond to natural rainfall as predicted by the Taylor Slough Rainfall formula. An additional operational component of the RPA for this area is the limitation of S-332D pumping during the CSSS breeding season. These operations intend to collect a greater percentage of the L-31N seepage lost from wetlands in ENP. Ideally this water will be passed westward and returned to ENP in the Taylor Slough basin. The C-111 element of the plan calls for no deviations from the operations of Test 7.

4.2.1.1 Differences between the RPA and IOP

Specific differences between the operational criteria of Test 7 Phases I and II, the RPA, and each of the IOP/ISOP proposed alternatives are presented in **Tables 4.2-4.7**. There are important distinctions between these scenarios that dictate whether they are successful in not only meeting the CSSS objectives, but in minimizing impacts to natural resources of the remnant Everglades. The primary differences between the RPA and IOP alternatives include:

- The RPA re-establishes a more natural spatial distribution of Shark Slough flows.
- The RPA increases operational stages in the L-31N and L-31W canals to levels closer to the authorized levels.
- Passive versus Non-passive implementation.

The fundamental difference between the RPA and the IOP alternative is the RPA attempts to create hydrologic conditions favorable to the CSSS by re-establishing a more natural spatial distribution of Shark Slough flows. Under the ISOP/IOP proposals, WCA-3A regulatory flows are diverted away from their historical downstream destinations and are sent to the SDCS. The necessity for such plans is derived from concerns over effects to private lands.

Another area that distinguishes the RPA from the ISOP/IOP alternatives is the operational criteria specific to the SDCS. Differences are present at a number of structures located along L-31N, and the L-31W canals that are shown in **Tables 4.1-4.7**. A notable difference between these tables occurs for stages in the L-31N canal, which would be operated to maintain Test 7 Phase II levels under the RPA. In contrast, the ISOP/IOP alternatives all maintain lower operational stages for this same reach of L-31N. Although the significance of 0.2 feet may be viewed as inconsequential, the relative magnitude of the change must be viewed in the context that minimum flows during this period to NESS will be either at or below those in Test 7. Downstream of S-331 to S-176, L-31N operational stages under the ISOP/IOP alternatives will be maintained 0.5 feet below those simulated in the RPA. Negative hydrologic impacts directly attributable to the lowered operational criteria and the resultant increase in seepage from the wetlands within ENP is supposedly offset by the operation of pump station S-332B. Explanation for the lowering of these canals center around mitigation from the diversion of WCA-3A regulatory flows to the SDCS. However, these criteria are in place year-round while WCA-3A regulatory flows to the

SDCS may occur for less than half the year.

4.2.1.2 Similarities between the IOP Alternatives

In the attempt to meet the project objectives, all the proposed alternatives, whether ISOP or IOP, contain certain operations that are characteristic of each of the alternatives.

- Diversion of a large portion of WCA-1 regulatory flows to tide via the Hillsboro Canal. To a lesser degree, regulatory flows from WCA-2A and WCA-3A are also sent to tide.
- Deviation from the regulation schedule in WCA-3A.
- Modification to the operational criteria of the WCA-3A outflow structures that discharge into Northwest Shark Slough (NWSS) or Big Cypress National Perserve (S-12`s, S-343`s, and S-344). These structures are closed at a certain date, depending on the alternative, after the onset of the dry season and re-opened on July 15^{th}.
- Regulatory releases from WCA-3A through structure S-151 and conveyed through S-337 to the SDCS or S-31 to tide.
- Conveyance of S-12D discharges routed down the L-67 Extension canal.
- Discharges from WCA-3B through the S-355 structures when the headwater at the structures reaches 8.5 feet. The structures are closed when the headwater drops back to 6.5 feet. The G-3273 constraint remains consistent with the Test 7 Phase I criteria.
- Modification of the L-29 canal stage to 9.0 feet.
- L-31N seepage control above G-211 facilitated by lowered S-338 and G-211 operational criteria and C-1W conveyance to tide. The G-211 criteria are lowered from 6.0/5.5 feet to 5.7/5.3 feet open/close.
- S-331 is operated as a flood control structure throughout the majority of the year
- Maintenance of significantly lowered L-31N canal stages above S-176 through lowering of operational criteria at S-196, S-194, S-332D and S-176. The open and close criteria for S-194 and S-196 are lowered to 4.7 and 4.2 feet respectively. This is much lower than the criteria for Test 7 Phase I which were open at 5.7 feet and close at 5.3 feet.
- Utilization of a new pump structure, S-332B, located on the west side of L-31N midway between S-331 and S-176.
- Unconstrained operational stages in L-31W and halting of operations at both S-332 and S-175. S-332D is not operated in conjunction with the Taylor Slough Rainfall Plan phase II levels.
- Lower C-111 operational stages at S-18C. The open and close criteria are dropped to 2.25 and 2.0 feet respectively for all alternatives. Operations at S-177 and S-197 do not vary between the alternatives.

4.2.2 Proposed Alternatives to the RPA/ IOP Alternatives

Representatives from many federal, state, and local agencies evaluated the operational criteria for the structures of the C&SF project and recommended changes that could positively influence water levels within the various CSSS sub-populations. Potential options for meeting the criteria stated in the FWS Biological Opinion were discussed and the corresponding modeling runs were analyzed and modified to produce the six operational alternatives. The following section includes a description of each of the six IOP alternatives with the intention of emphasizing the differences between alternatives. The operational criteria mentioned above are present in each alternative described below and therefore will not be discussed in the alternative descriptions.

4.2.2.1 Alternative 1 ("No-Action" Alternative)

Currently the C&SF system operates under the criteria specified in Alternative 1 (ISOP9DR), the "No-Action" alternative. A summary of the operational criteria for Alternative 1 is given in **Table 4.2**. This alternative was developed from the original ISOP operations implemented in March 2000. Modifications were made subsequent to the initial operating plan in order to address concerns that the earlier ISOP operations failed to meet the hydrologic equivalence of the RPA criteria set forth in the FWS Biological Opinion for the CSSS sub-populations. **Figure 4.2** is a conceptual diagram of the structural operations and redistribution of flows under Alternative 1 relative to Test 7 Phase I. A description of the original adjustments to operations along with the evolution to the current operations (Alternative 1) is given below.

Deviations to the regulation schedule for WCA-2A and WCA-3A were developed in order to hold storm water run-off from upstream basins during high rainfall periods in the conservation areas and prevent the excessive discharges to ENP through the S-12 structures. The closure of the S-11 structures under the WCA-2A deviation schedule is intended to help alleviate the high water conditions in WCA-3A that could potentially occur with the early closure of the S-12 structures. In accordance with the delayed release of regulatory flows as per the WCA-3A deviation schedule, the S-343 structures and S-344 are to be closed as of November 1st of each year. To further reduce the risk of high water in the western habitat of the CSSS, the mandatory closure date for S-12A, the structure closest to this habitat, was moved back to November 1st. In following, S-12B shall be closed on January 1st with S-12C shut on February 1st. The mandatory closure date for S-12D was removed from the operational plan and the structure currently operates in accordance with the WCA-3A deviation schedule year round. The above structures affected by the early closure dates would all resume operations under the WCA-3A deviation schedule after July 15th, the recognized final day of the CSSS nesting season. The deviation schedule for WCA-2A was eventually removed from the ISOP and is not a part of the "No-Action" alternative. To compensate for the early closure of the S-12, S-343 and S-344 structures, S-151 and S-337 work in conjunction to discharge regulatory releases from WCA-3A according to the WCA-3A deviation schedule.

Operations at S-333 remain similar to those under Test 7 Phase I of the Experimental Water Deliveries Program although the role of the structure is changed. As shown in **Figure 4.2**, S-333 is used in conjunction with S-334 to pass large flow volumes from WCA-3A into the SDCS. When the G-3273 trigger well stage is below 6.8 feet, S-333 may discharge its portion of the Shark Slough rainfall formula target flow which is 55% of the sum of the rainfall formula target plus the regulatory discharge as determined by the WCA-3A regulation schedule. However, with the potential early closure of some of the S-12 structures, S-333 is also permitted to pass additional water beyond the 55% of target flows recommended by the rainfall plan. Under ISOP operations, S-333 can pass as much of the remaining 45% as possible without exceeding the de-

Table 4.2. Summary of operational criteria for Alternative 1 (No-Action) simulation.

	Alternative 1 (No-Action)
Regulation Schedule	Regulation Schedule Deviation schedules for WCA 3A as specified by USACE including raising Zone D to Zone C from Nov 1 to Feb 11.
S-343 A/B and S-344	Closed Nov 1 to July 15 independent of WCA-3A levels.
S-12 A/B/C/D	S-12A closed Nov 1 to Jul 15; S-12B closed Jan 1 to Jul 15; S-12C closed Feb 1 to Jul 15; S-12D operated normally according to WCA 3A schedule. Follow WCA 3A regulation schedule after Jul 15.
S-333: G-3273 < 6.8'	55% of the rainfall plan target to NESRS, plus as much of the remaining 45% that the S-12's can't discharge to be passed through S-334; and subject to capacity constraints, which are 1350 cfs at S-333, L-29 maximum stage limit, and canal stage limits downstream of S-334.
S-333: G-3273 > 6.8'	No discharge to NESRS; release 55% of the rainfall plan target, plus as much of the remaining 45% that the S-12's can't discharge through S-333 and S-334, sucject to capacity constraints.
L-29 constraint	9.0 ft
S-355A&B	Dry Wet Open 8.50 8.50 Close 6.50 6.50
S-337	Regulatory releases as per WCA-3A deviation schedule.
S-151	Regulatory releases as per WCA-3A deviation schedule.
S-335	Open at 7.5; Close at 7.2
S-334	Same as 95Base except that it also may pass all or part of S-333 releases to the SDCS, depending on stage at G-3273.
S-338	Open at 5.8; Close at 5.4. Operated to maximize discharges to coast.
G-211	Open at 5.7; Close at 5.3.
S-331	Start pump at 4.8; pump down to 4.3.
S-332B	Pumped up to 325 cfs from Jun through Jan; 125 cfs from Feb through May; Dry Wet On 4.7 4.7 Off 4.2 4.2
S-332B Seepage Reservoir	Seepage Reservoir 160 acres with emergency overflow.
S-332D	Pumped up to 500 cfs design capacity from Jul 16 to Nov 30; 325 cfs from Dec 1 to Jan 31; and 165 cfs from Feb 1 to Jul 15. Dry Wet On 5.0 4.5 Off 4.8 4.0
S-332	Closed
S-175	Closed
S-194	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20
S-196	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20
S-176	Dry Wet Open 4.70 4.70 Close 4.50 4.50
S-177	Open at 4.2; Close at 3.6
S-18C	Dry Wet Open 2.25 2.25 Close 2.00 2.20
S-197	Same as Test 7 Phase I; Close at 2.3

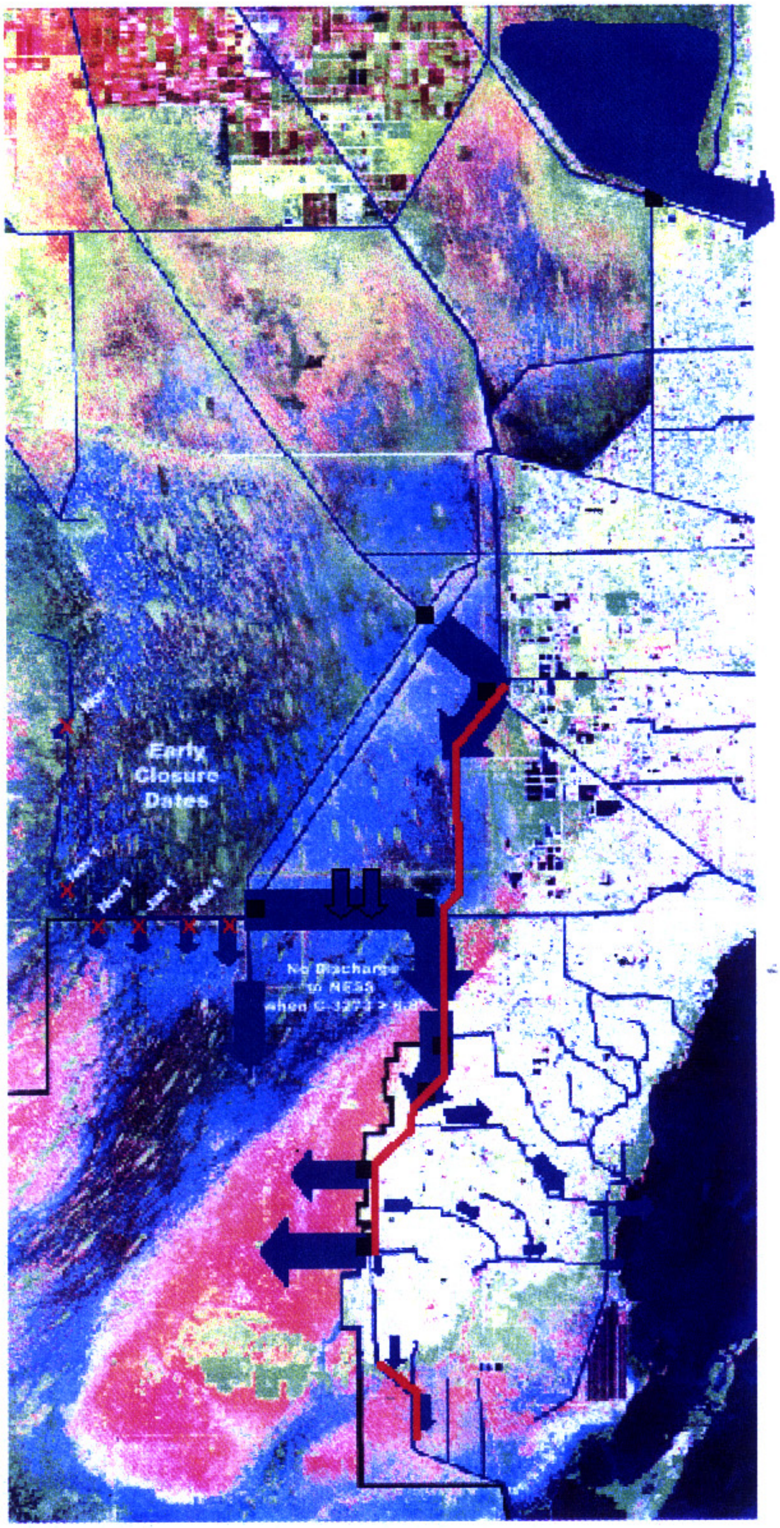


Figure 4.2. Conceptual diagram of operations and flow redistribution under Alternative 1 relative to Test 7 Phase I.

sign capacity of the structure, provided this water can be passed through S-334 without causing canal stages downstream of S-334 to exceed specified levels. When the G-3273 trigger well criteria is above 6.8 feet, all WCA-3A regulatory flows to the SDCS passed through S-333 are subject to the constraints of the design capacity of the structure, water level in the L-29 canal and in the L-31N downstream of S-334. At no time may outflows through S-333 be allowed to raise the stage in the L-29 canal above 9.0 feet. Outflows from WCA-3B via the S-355's also enter the L-29 canal subject to the G-3273 constraint and must be passed through S-334. However, in the case of the S-355's the L-29 constraint is 8.0 feet. Regardless of the source of the surface flows during these times the majority of water passed through S-334 is sent through G-211 and S-331 due to the lowered operational criteria at G-211. Test 7 Phase I operational criteria for G-211 was open at a headwater of 6.0 feet and close at 5.5 feet. In Alternative 1 the criteria are lowered to a 5.7 feet open and a 5.3 feet close. The strategy appears to continue drainage of NESS but at least pass the seepage volume to the CSSS sub-populations downstream. Some of this water is lost to tide through the C-102 and C-103 canals. The remainder is diverted clear around NESS and is put back into ENP at S-332B and S-332D.

A major component of the ISOP is the S-332B pump station. The stated intention of the pump station is to return water to the Rocky Glades that is lost to the east through seepage into the L-31N canal. Initially the pump was operated to put up to 500 cfs of water from the L-31N canal into a hypothetical 160 acre seepage reservoir adjacent to ENP in an effort to rehydrate the Rocky Glades region in the vicinity of sub-population F of the CSSS. After field observations of how water levels in the detention area responded to pumping at S-332B, the maximum pumping rate was reduced to 325 cfs. Concern over adverse hydrologic impacts to sub-population F resulted in a reduced pumping rate of 125 cfs from February to May. Although the reservoir was designed with emergency overflow capacity, explicit definition of what constitutes an emergency has never been defined. Since the maximum design pumping rates occur during the wetter periods of the year, it appears that the emergency must be associated with flood control operations. Under the ISOP, S-332B is turned on when the L-31N canal reaches 4.7 feet and shuts off when the canal drops to 4.2 feet. There is no stated operation for how the pump station will return seepage lost to the L-31N canal after the canal drops below 4.2 feet.

Under the ISOP, water levels in the L-31N canal are held lower than at any other time during the operation of the SDCS. Drainage divide structures S-194 and S-196 operate under the same criteria, opening when the headwater reaches 4.7 feet and closing when the headwater drops below 4.2 feet. These criteria are 1.0 feet lower than the open and close criteria of 5.7 and 5.2 feet, respectively, that was originally authorized and operated during Test 7. During the wet season, S-332D begins pumping when the headwater at the structure reaches 4.5 feet and stops pumping when the headwater drops below 4.0 feet. Open and close criteria during the dry season for S-332D is 5.0 feet and 4.8 feet respectively. Pumping at S-332D is limited to 325 cfs during December and January and to 165 cfs from February to the end of the CSSS nesting season on July 15th. S-176 also opens when the headwater at the structure reaches 4.7 feet with the closing set at 4.5 feet. Given these criteria for the structures along the lower reach of the L-31N canal stages will be maintained below 4.7 feet with the exception of extreme rainfall events. Water entering the canal from S-331 or from seepage from the Rocky Glades and NESS is first sent through S-332D, into L-31W and towards Taylor Slough. If the canal continues to rise with the progression of the wet season, the remaining structures will all open in coincidence when the water level reaches 4.7 feet. During periods when the canal level is receding, S-176 is the first to close at 4.5 feet with S-332D shutting off last when the canal level has returned to 4.0 feet. During the dry season, the role of S-332D is reversed, as the pump station will only begin pumping after all the other structures have opened. The large increases in pumping at S-332B and S-332D are supposed to offset the increased flows coming down the SDCS from WCA-3A. However, pumping at lower canal stages in L-31N downstream of S-331 suggest that some of this water is inevitably derived from seepage from ENP.

Early on in the development of the ISOP, it was decided that the S-332 pump station and structure S-175 would no longer be used to deliver water to Taylor Slough or control water levels in the L-31W canal. S-332D is permitted to pump in order to meet the Taylor Slough Rainfall Formula stages in L-31W. There was no original intention to allow S-332D to augment the capacity for WCA-3A regulatory flows associated with the ISOP/IOP or to operate as a mechanism to enhance "flood protection" of upstream basins. Instead S-332D flows were to maintain higher stages in the L-31W canal and when applicable flow over the western bank of the canal, thus contributing water to Taylor Slough over a larger area. These events were intended to be in response to the natural occurrence of rainfall within the Taylor Slough basin.

Operating criteria at S-177 remains the same as in Test 7 Phase I, with the structure opening at a headwater of 4.2 feet and closing when the level dropped to 3.6 feet. Under the ISOP, changes to operations in the C-111 basin are focused on the S-18C structure. At first unchanged, the open and close criteria at S-18C were eventually lowered under the ISOP. Gate openings are now initiated when the headwater reaches 2.25 feet as opposed to the 2.6 feet criteria in Test 7 Phase I. S-18C is closed once the headwater has returned to 2.0 feet, 0.3 feet lower than the Test 7 Phase I criteria of 2.3 feet. No changes have been made at S-197, which continues to operate according to the Test 7 Phase I criteria.

4.2.2.2 Alternatives 2 through 6

The following IOP alternatives were formulated in two phases. Operations in Phase I would continue until the construction of the 8.5 Square Mile Area project. Upon completion of this project the G-3273 trigger well constraint on S-333 operations would be removed for Phase II operations of each alternative.

4.2.2.2.1 Alternative 2

Table 4.3 summarizes the operational criteria for Alternative 2. A conceptual diagram of the operational changes in Alternative 2 relative to Test 7 Phase I is shown in **Figure 4.3**. Under Alternative 2 the deviation schedule for WCA-2A is in place for both Phase I and Phase II. The first mandatory closure of the southern outlet structures of WCA-3A is at S-12A on December 1st. S-343 A&B and S-344 must be closed on January 1st along with S-12B. S-12D also must close on February 1st along with S-12C. Again, large regulatory discharges are made via S-151 and subsequently routed through S-337 into the L-30 canal. Operations at S-333 are the same as those in Alternative 1 for Phase I of Alternative 2. S-334 is operated to accommodate WCA-3A regulatory flows to the SDCS through S-333 as described above for Alternative 1. For S-333 and S-334, Phase II operations allow for S-333 to pass 55% of the Shark Slough rainfall formula flows up to the maximum structural design capacity of 1350 cfs with the G-3273 trigger well constraint removed. As noted previously, with the resolution of the 8.5 Square Mile Area project, WCA-3A regulatory to SDCS are not required to pass through S-334. In Phase II S-334 will revert to it's originally authorized water supply function.

Water diverted from WCA-3A through S-333 and S-334 is passed through G-211 and S-331 into the lower reach of the L-31N canal. Here it is dispersed through five different outlet points. The S-332B and S-332D pump stations serve as the major outflow points from the lower L-31N canal. The operating criteria at S-332B remain the same as in Alternative 1 with the maximum pumping rate raised to 375 cfs year round. In Phase II the operating criteria are lowered to 4.5 feet and 4.0 feet for the on and off levels and the maximum discharge is lowered to 325 cfs. The pumping rate at S-332D, compared to Alternative 1, is raised during the month of January from 165 cfs to 325 cfs for Phase I only. Phase II operations at S-332D are identical to Alternative 1. Water not sent through the pump stations is sent to tide through the C-102 and C-103 canals or to the C-111 basin through S-176. The operating criteria for S-176 remains the same as in Alternative 1 during Phase I of Alternative 2. Phase II allows the open and close criteria at S-176 to return to Test 7 Phase I levels of 5.0 and 4.75, respectively. As in Alternative 1, S-332D begins operations along the lower L-31N canal during the wet season before all other structures (i.e. S-332B, S-194, S-196, S-176). During the dry season the opposite is true with S-332D coming on after all other structures have opened.

4.2.2.2.2 Alternative 3

Alternative 3 possesses similar operational criteria to those described in Alternative 2 for Phase I while the Phase II criteria for Alternatives 2 and 3 are identical **(see Table 4.3)**. However, **Figure 4.3** shows some significant changes in the redistribution of flows from WCA-3A. One major change occurs downstream of S-151 along the Miami Canal. Regulatory releases from WCA-3A are no longer routed through S-337 into the L-30 canal. Instead some of these additional flows are sent through S-31 down the Miami Canal where they are eventually discharged to tide. Mandatory closure dates for the southern outlet structures of WCA-3A are identical to the dates set in Alternative 2 and are shown in **Figure 4.3**. Operations at S-333 are the same as the operations described in Test 7 Phase I for Phase I of Alternative 3. During Phase II of Alternative 3 the operations shift to those described above in Phase II of Alternative 2. The G-3273 trigger well criterion has been removed and S-333 is permitted to pass 55% of the Shark Slough rainfall formula target flows up to the design capacity of the structure (1350 cfs).

According to the operations specified in Alternative 3, WCA-3A regulatory flows to the SDCS via S-334 will not occur. Since S-31 is diverting a portion of the S-151 regulatory releases, Alternative 3 can be expected to send less water into the SDCS than Alternatives 1 or 2. With diminished WCA-3A regulatory flows routed to the SDCS, it would be reasonable to assume that mitigation for these flows through lowering of the L-31N operational criteria for S-332B and S-332D might not be necessary. However, this is clearly not reflected in the operational criteria at

Table 4.3. Summary of operational criteria for Alternative 2 simulation.

Alternative 2		
	Phase I	**Phase II**
Regulation Schedule	Deviation schedules for WCA 2A (S-11 A,B,C structures closed) and 3A as specified by USACE.	Deviation schedules for WCA 2A (S-11 A,B,C structures closed) and 3A as specified by USACE.
S-343 A/B and S-344	Closed Jan 1 to July 15 independent of WCA-3A levels.	Closed Jan 1 to July 15 independent of WCA-3A levels.
S-12 A/B/C/D	S-12A closed Dec 1 to Jul 15; S-12B closed Jan 1 to Jul 15; S-12 C,D closed Feb 1 to Jul 15; Follow WCA 3A regulation schedule after Jul 15.	S-12A closed Dec 1 to Jul 15; S-12B closed Jan 1 to Jul 15; S-12 C, D closed Feb 1 to Jul 15; Follow WCA 3A regulation schedule after Jul 15.
S-333: G-3273 < 6.8'	55% of the rainfall plan target to NESRS, plus as much of the remaining 45% that the S-12s can't discharge to be passed through S-334; and subject to capacity constraints, which are 1350 cfs at S-333, L-29 maximum stage limit, and canal stage limits downstream of S-334.	S-333 open to deliver 55% of Shark Slough target flows as per rain-fall plan target (rainfall formula + WCA 3A regulatory discharge).
S-333: G-3273 > 6.8'	No discharge to NESRS; release 55% of the rainfall plan target, plus as much of the remaining 45% that the S-12s can't discharge through S-333 and S-334, subject to capacity constraints.	Maximum possible discharge subject to S-333 design capacity (1350 cfs) with G-3273 trigger removed.
L-29 constraint	9.0 ft	9.0 ft
S-355A&B	Dry Wet Open 8.50 8.50 Close 6.50 6.50	Dry Wet Open 8.50 8.50 Close 6.50 6.50
S-337	Regulatory releases as per WCA-3A deviation schedule.	Regulatory releases as per WCA-3A deviation schedule.
S-151	Regulatory releases as per WCA-3A deviation schedule.	Regulatory releases as per WCA-3A deviation schedule.
S-335	Open at 7.5; Close at 7.2	Open at 7.5; Close at 7.2
S-334	Passes S-333 regulatory releases to SDCS	Closed
S-338	Open at 5.8; Close at 5.4. Operated to maximize discharges to coast.	Open at 5.8; Close at 5.4. Operated to maximize discharges to coast.
G-211	Open at 5.7; Close at 5.3.	Open at 5.7; Close at 5.3.
S-331	Start pump at 4.8; pump down to 4.3.	Start pump at 4.8; pump down to 4.3.
S-332B	Pump up to 375 cfs; On at 4.7, Off at 4.2	Pump up to 325 cfs; On at 4.5, Off at 4.0
S-332B Seepage Reservoir	160 acres with emergency overflow.	160 acres with emergency overflow.
S-332D	Pump up to 500 cfs from Jul 16 to Nov 30; 325 cfs from Dec 1 to Jan 31; and 165 cfs from Feb 1 to Jul 15. Dry Wet On 5.00 4.50 Off 4.80 4.00	Pump up to 500 cfs from Jul 16 to Nov 30; 325 cfs from Dec 1 to Jan 31; and 165 cfs from Feb 1 to Jul 15. Dry Wet On 5.00 4.50 Off 4.80 4.00
S-332	Closed	Closed
S-175	Closed	Closed
S-194	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20
S-196	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20
S-176	Dry Wet Open 4.70 4.70 Close 4.50 4.50	Dry Wet Open 5.00 5.00 Close 4.75 4.75
S-177	Open at 4.2; Close at 3.6	Open at 4.2; Close at 3.6
S-18C	Dry Wet Open 2.25 2.25 Close 2.00 2.00	Dry Wet Open 2.25 2.25 Close 2.00 2.00
S-197	Same as Test 7 Phase I; Close at 2.3	Same as Test 7 Phase I; Close at 2.3

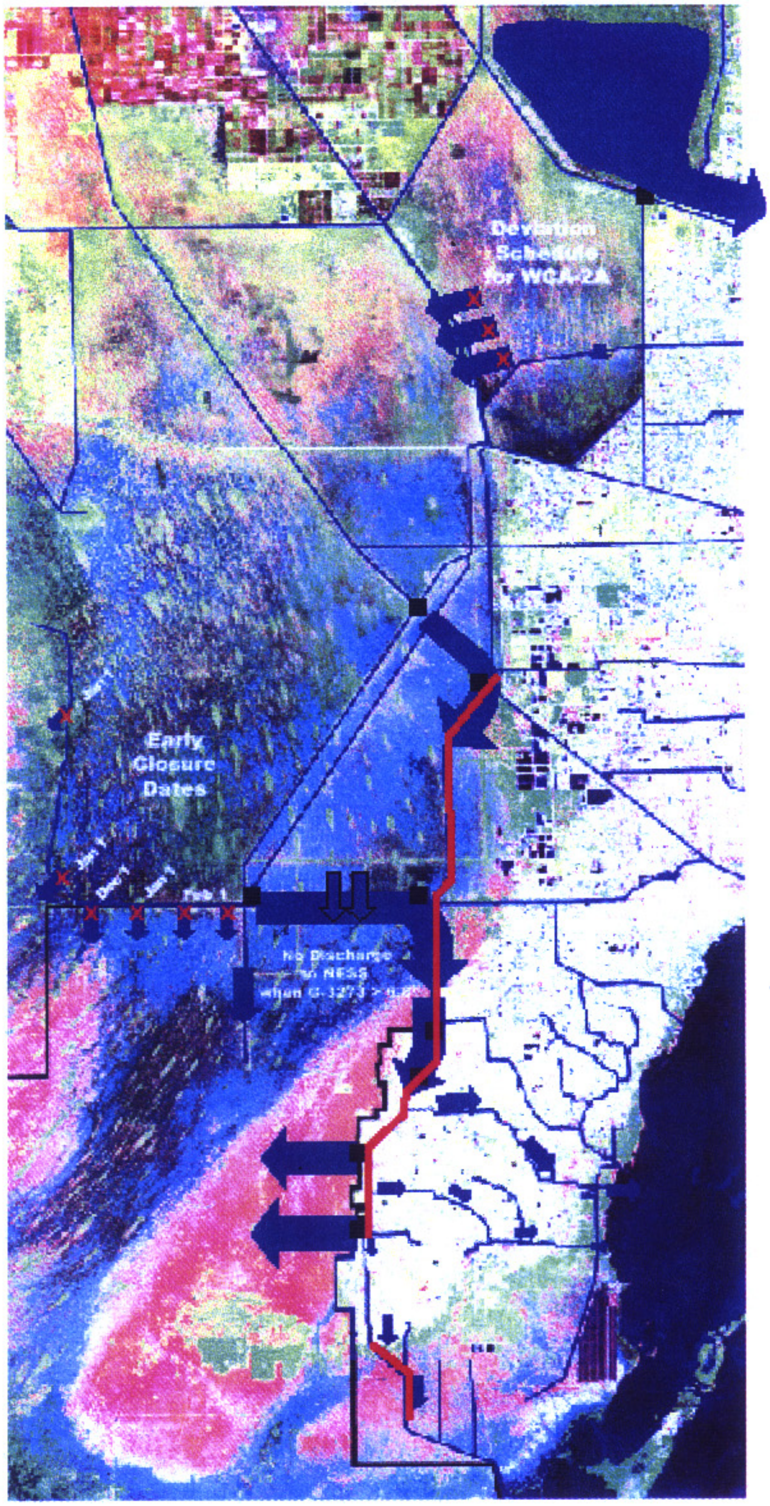


Figure 4.3. Conceptual diagram of operations and flow redistribution under Alternative 2 Phase I relative to Test 7 Phase I.

these structures. To the contrary, under both phases of Alternative 3, the operational criteria for S-332B and S-332D are the same as the criteria for Alternative 2 Phase II without the benefit of increased surface water flows to NESS. Pumping at S-332B begins when the headwater in the L-31N canal reaches 4.5 feet and stops when the level drops to 4.0 feet, levels which are lower than Alternative 2 Phase I. As shown in **Table 4.3**, the on and off criteria for the S-332D pump station are the same as in Alternative 2. Additional flow volumes that are passed through S-331 that are not returned to ENP at S-332B and S-332D are sent to tide via the C-102 and C-103 canals. None of the extra water coming down the SDCS is sent into the C-111 basin. S-176 operations are the same as those of Test 7 Phase I with the structure opening at a headwater of 5.0 feet and closing at 4.75 feet. During the wet season along the L-31N canal, Alternative 3 calls for pumping to begin at S-332B and S-332D first, when the L-31N canal reaches 4.5 feet. As water levels rise with the progression of the wet season, structures S-194 and S-196 open next when the canal reaches 4.7 feet to send water eastward. Water is sent to the C-111 basin last when the headwater at S-176 reaches 5.0 feet. Dry season operations differ by keeping S-332D off until the L-31N canal has reached 5.0 feet.

4.2.2.2.3 Alternative 4

Alternative 4 is the only alternative to recommend deviation schedules in WCA-1, WCA-2A and WCA-3A **(see Table 4.5)**. By holding water back in these three upstream conservation areas, Alternative 4 is able to permit closing of all of the WCA-3A southern outlet structures (S12A-D, S-343 A&B and S-344) by November 1st. A conceptual interpretation of the operations and redistribution of flows relative to Test 7 Phase I is shown in **Figure 4.5**. Alternative 4 calls for large WCA-3A regulatory discharges to tide via S-151 and S-31 down the Miami Canal. Operations at S-333 are identical to those described for Alternative 3 for both Phase I and II. The G-3273 trigger well constraint on S-333 operations is removed under Phase II. In both Phase I and II S-334 reverts back to the originally authorized water supply purpose.

Again as in Alternative 3, the motivation of increased pumping at S-332B and S-332D to mitigate for the additional regulatory releases from WCA-3A to the SDCS remains unclear. Since S-334 is used for water supply only and S-31 appears to be the major outlet for regulatory flows sent through S-151, decreased WCA-3A regulatory flows to the SDCS would be expected. Presumably, the lower operational criteria associated with the L-31N canal is to capture drainage from NESS due to the lower G-211 operational criteria. Sustained pumping at S-332B and S-332D during periods in which no WCA-3A regulatory flows reach the SDCS or NESS seems counter intuitive. Operations at S-332B and S-332D are identical in Alternatives 3 and 4 for both Phase I and Phase II **(see Table 4.4)**. Any additional flows not pumped back towards the Park are sent to tide via the C-102 and C-103 canals. No additional flows are sent to the C-111 basin. The S-176 criteria remains the same as the Test 7 Phase I criteria with the structure opening at a headwater level of 5.0 feet and closing at 4.75 feet. The timing of structure operations along the L-31N canal is identical to Alternative 3 described above.

Table 4.4. Summary of operational criteria for Alternative 3 simulation.

	Alternative 3	
	Phase I	**Phase II**
Regulation Schedule	Deviation schedules for WCA 2A (S-11 A,B,C structures closed) and 3A as specified by USACE.	Deviation schedules for WCA 2A (S-11 A,B,C structures closed) and 3A as specified by USACE.
S-343 A/B and S-344	Closed Jan 1 to July 15 independent of WCA-3A levels.	Closed Jan 1 to July 15 independent of WCA-3A levels.
S-12 A/B/ C/D	S-12A closed Dec 1 to Jul 15; S-12B closed Jan 1 to Jul 15; S-12 C,D closed Feb 1 to Jul 15; Follow WCA 3A regulation schedule after Jul 15.	S-12A closed Dec 1 to Jul 15; S-12B closed Jan 1 to Jul 15; S-12 C,D closed Feb 1 to Jul 15; Follow WCA 3A regulation schedule after Jul 15.
S-333: G-3273 < 6.8'	S-333 open to deliver 55% of Shark Slough target flows as per rainfall plan target (rainfall formula + WCA-3A regulatory discharge)	S-333 open to deliver 55% of Shark Slough target flows as per rainfall plan target (rainfall formula + WCA-3A regulatory discharge)
S-333: G-3273 > 6.8'	S-333 closed	Maximum possible discharge subject to S-333 design capacity (1350 cfs) with G-3273 trigger removed.
L-29 constraint	9.0 ft	9.0 ft
S-355A&B	Dry Wet Open 8.50 8.50 Close 6.50 6.50	Dry Wet Open 8.50 8.50 Close 6.50 6.50
S-337	Regulatory releases as per WCA-3A deviation schedule.	Regulatory releases as per WCA-3A deviation schedule.
S-151	Regulatory releases as per WCA-3A deviation schedule.	Regulatory releases as per WCA-3A deviation schedule.
S-335	Open at 7.5; Close at 7.2	Open at 7.5; Close at 7.2
S-334	Closed	Closed
S-338	Open at 5.8; Close at 5.4. Operated to maximize discharges to coast.	Open at 5.8; Close at 5.4. Operated to maximize discharges to coast.
G-211	Open at 5.7; Close at 5.3.	Open at 5.7; Close at 5.3.
S-331	Start pump at 4.8; pump down to 4.3.	Start pump at 4.8; pump down to 4.3.
S-332B	Pumped up to 325 cfs; On at 4.5, Off at 4.0	Pumped up to 325 cfs; On at 4.5, Off at 4.0
S-332B Seepage Reservoir	160 acres with emergency overflow.	160 acres with emergency overflow.
S-332D	Pumped up to 500 cfs from Jul 16 to Nov 30; 325 cfs from Dec 1 to Jan 31; and 165 cfs from Feb 1 to Jul 15. Dry Wet On 5.00 4.50 Off 4.80 4.00	Pumped up to 500 cfs from Jul 16 to Nov 30; 325 cfs from Dec 1 to Jan 31; and 165 cfs from Feb 1 to Jul 15. Dry Wet On 5.00 4.50 Off 4.80 4.00
S-332	Closed	Closed
S-175	Closed	Closed
S-194	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20
S-196	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20
S-176	Dry Wet Open 5.00 5.00 Close 4.75 4.75	Dry Wet Open 5.00 5.00 Close 4.75 4.75
S-177	Open at 4.2; Close at 3.6	Open at 4.2; Close at 3.6
S-18C	Dry Wet Open 2.25 2.25 Close 2.00 2.00	Dry Wet Open 2.25 2.25 Close 2.00 2.00
S-197	Same as Test 7 Phase I; Close at 2.3	Same as Test 7 Phase I; Close at 2.3

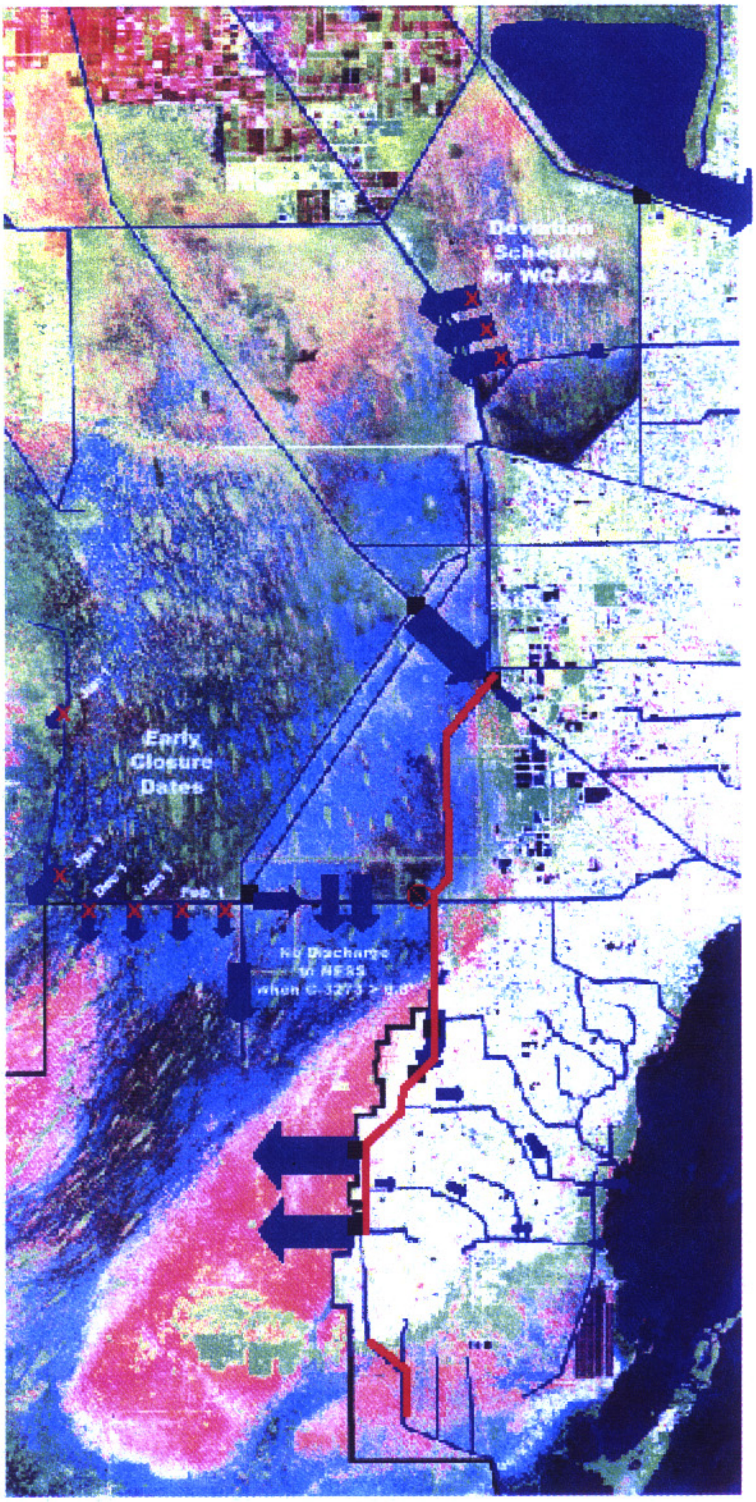


Figure 4.4. Conceptual diagram of operations and flow redistribution under Alternative 3 Phase I relative to Test 7 Phase I.

4.2.2.2.4 Alternative 5

Operational criteria for Alternative 5 are listed in **Table 4.6**. Alternative 5 contains a deviation schedule for WCA-3A only. **Figure 4.6** presents a conceptual diagram of the changes in operations under Alternative 5 relative to Test 7 Phase I. As in Alternatives 1 and 2, regulatory releases from WCA-3A through S-151 are primarily sent through S-337 into the L-30 canal. Mandatory closure of S-12A, S-343 A&B and S-344 occurs on November 1st, similar to Alternatives 1 and 4. S-12B is scheduled to be shut on January 1st with S-12C closed on February 1st. S-12D will continue to operate under the WCA-3A regulation schedule throughout the entire year. During Phase I of Alternative 5 operations at S-333 are identical to those of Alternative 1. Outflows from WCA-3A in excess of the rainfall formula that are passed through S-333 are subsequently passed through S-334 into the SDCS. Outflows from WCA-3B through the S-355 structures can enter NESS or be passed through S-334. The only change to S-333 operations under Phase II is that the G-3273 trigger well constraint is removed and S-333 is permitted to pass up to the design capacity of the structure (1350 cfs). S-334 is to be closed except when operating as a water supply structure.

Additional regulatory releases from WCA-3A to the SDCS are conveyed through G-211 and S-331 with the expectation that the majority of this additional flow is pumped towards ENP through S-332B and S-332D. Alternative 5 is the first alternative to present operational criteria at S-332B that differ between the wet and dry season **(see Table 4.5)**. The wet season pumping criteria at S-332D are higher under Alternative 5 than under Alternatives 1 through 4. Periods of restricted pumping rates are identical to those of Alternatives 1, 3 and 4. Phase I and Phase II operations for S-332D are identical in Alternative 5 **(see Table 4.5)**. Additional water put into the SDCS that is not pumped through S-332B and S-332D is diverted to tide through the C-102 and C-103 canals. Alternative 5 specifies different operational criteria between the wet and dry season for S-176 **(see Table 4.6)**. No additional water is diverted to the C-111 basin. Under Alternative 5, the timing of structure operations along the L-31N canal is different from previous alternatives. During the wet season S-332B, S-332D, S-194 and S-196 all open at a headwater level of 4.7 feet with S-176 opening last at 4.8 feet. During the dry season the S-332B and S-332D pump stations open last while the stage divide structures S-194 and S-196 open first.

4.2.2.2.5 Alternative 6

Alternative 6 is identical to Alternatives 1 and 5 for operational criteria concerning WCA-3A and its southern outflow structures **(see Table 4.7)**. The deviation schedule is in place for WCA-3A only. Mandatory closure dates are listed in **Table 4.7** and on **Figure 4.7**. Operations at S-333 are identical to those described for Alternative 5 for both Phase I and Phase II. **Figure 4.7** shows the similarities between Alternatives 5 and 6 for the flow routing from WCA-3A through S-151/S-337 and S-333/S-334.

The first noticeable change seen in **Figure 4.7** for Alternative 6 compared to Alternative 5 is at S-332B. Besides the lowering of capacity at S-332B to 250 cfs the area of the detention reservoir is increased to 400 acres. The additional 240 acres beyond the original 160 acres specified

Table 4.5. Summary of operational criteria for Alternative 4 simulation.

	Alternative 4	
	Phase I	**Phase II**
Regulation Schedule	Regulation Schedule Deviation schedules for WCA 1, 2A, and 3A as specified by USACE.	Regulation Schedule Deviation schedules for WCA 1, 2A, and 3A as specified by USACE.
S-343 A/B and S-344	Closed Nov 1 to July 15 independent of WCA-3A levels.	Closed Nov 1 to July 15 independent of WCA-3A levels.
S-12 A/B/ C/D	S-12A, B, C and D closed Nov 1 to Jul 15; Follow WCA 3A regulation schedule after Jul 15.	S-12A, B, C and D closed Nov 1 to Jul 15; Follow WCA 3A regulation schedule after Jul 15.
S-333: G-3273 < 6.8'	S-333 open to deliver 55% of Shark Slough target flows as per rainfall plan target (rainfall formula + WCA-3A regulatory discharge)	S-333 open to deliver 55% of Shark Slough target flows as per rainfall plan target (rainfall formula + WCA-3A regulatory discharge)
S-333: G-3273 > 6.8'	S-333 closed	Maximum possible discharge subject to S-333 design capacity (1350 cfs) with G-3273 trigger removed.
L-29 constraint	9.0 ft	9.0 ft
S-355A&B	Dry Wet Open 8.50 8.50 Close 6.50 6.50	Dry Wet Open 8.50 8.50 Close 6.50 6.50
S-337	Regulatory releases as per WCA-3A deviation schedule.	Regulatory releases as per WCA-3A deviation schedule.
S-151	Regulatory releases as per WCA-3A deviation schedule.	Regulatory releases as per WCA-3A deviation schedule.
S-335	Open at 7.5; Close at 7.2	Open at 7.5; Close at 7.2
S-334	Closed	Closed
S-338	Open at 5.8; Close at 5.4. Operated to maximize discharges to coast.	Open at 5.8; Close at 5.4. Operated to maximize discharges to coast.
G-211	Open at 5.7; Close at 5.3.	Open at 5.7; Close at 5.3.
S-331	Start pump at 4.8; pump down to 4.3.	Start pump at 4.8; pump down to 4.3.
S-332B	Pumped up to 325 cfs; On at 4.50, Off at 4.00	Pumped up to 325 cfs; On at 4.50, Off at 4.00
S-332B Seepage Reservoir	160 acres with emergency overflow.	160 acres with emergency overflow.
S-332D	Pumped up to 500 cfs from Jul 16 to Nov 30; 325 cfs from Dec 1 to Jan 31; and 165 cfs from Feb 1 to Jul 15. Dry Wet On 5.00 4.50 Off 4.80 4.00	Pumped up to 500 cfs from Jul 16 to Nov 30; 325 cfs from Dec 1 to Jan 31; and 165 cfs from Feb 1 to Jul 15. Dry Wet On 5.00 4.50 Off 4.80 4.00
S-332	Closed	Closed
S-175	Closed	Closed
S-194	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20
S-196	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20
S-176	Dry Wet Open 5.00 5.00 Close 4.75 4.75	Dry Wet Open 5.00 5.00 Close 4.75 4.75
S-177	Open at 4.2; Close at 3.6	Open at 4.2; Close at 3.6
S-18C	Dry Wet Open 2.25 2.25 Close 2.00 2.00	Dry Wet Open 2.25 2.25 Close 2.00 2.00
S-197	Same as Test 7 Phase I; Close at 2.3	Same as Test 7 Phase I; Close at 2.3

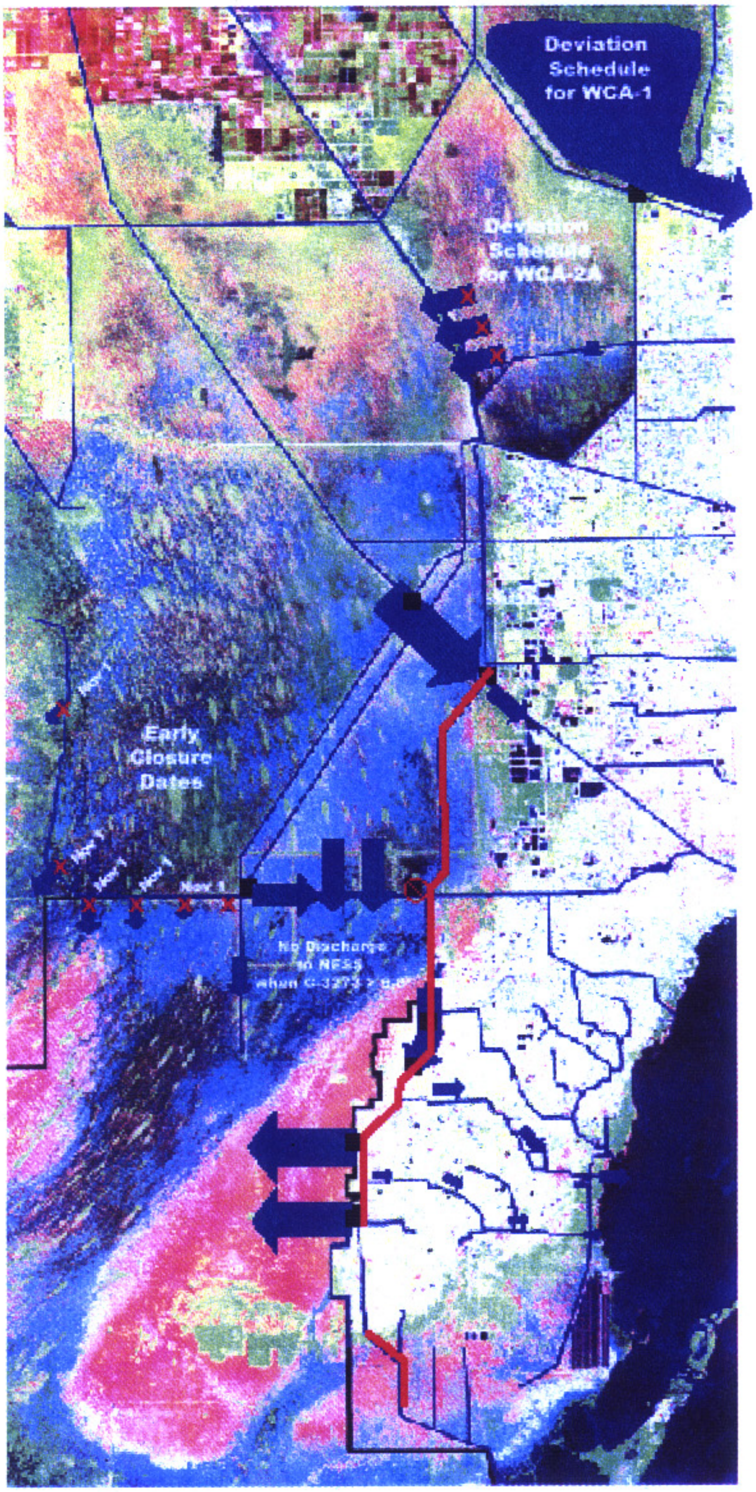


Figure 4.5. Conceptual diagram of operations and flow redistribution under Alternative 4 Phase I relative to Test 7 Phase I.

Table 4.6. Summary of operational criteria for Alternative 5 simulation.

	Alternative 5	
	Phase I	Phase II
Regulation Schedule	Regulation Schedule Deviation for WCA-3A as specified by USACE including raising Zone D to Zone C from Nov 1 to Feb 11. No deviation in WCA-2A regulation schedule.	Regulation Schedule Deviation for WCA-3A as specified by USACE including raising Zone D to Zone C from Nov 1 to Feb 11. No deviation in WCA-2A regulation schedule.
S-343 A/B and S-344	Closed Nov 1 to July 15 independent of WCA-3A levels.	Closed Nov 1 to July 15 independent of WCA-3A levels.
S-12 A/B/C/D	S-12A closed Nov 1 to Jul 15; S-12B closed Jan 1 to Jul 15; S-12 C,D closed Feb 1 to Jul 15; Follow WCA 3A regulation schedule after Jul 15	S-12A closed Nov 1 to Jul 15; S-12B closed Jan 1 to Jul 15; S-12 C,D closed Feb 1 to Jul 15; Follow WCA 3A regulation schedule after Jul 15
S-333: G-3273 < 6.8'	55% of the rainfall plan target to NESRS, plus as much of the remaining 45% that the S-12s can't discharge to be passed through S-334; and subject to capacity constraints, which are 1350 cfs at S-333, L-29 maximum stage limit, and canal stage limits downstream of S-334.	55% of the rainfall plan target to NESRS, plus as much of the remaining 45% that the S-12s can't discharge to be passed through S-334; and subject to capacity constraints, which are 1350 cfs at S-333, L-29 maximum stage limit, and canal stage limits downstream of S-334.
S-333: G-3273 > 6.8'	No discharge to NESRS; release 55% of the rainfall plan target, plus as much of the remaining 45% that the S-12s can't discharge through S-333 and S-334, subject to capacity constraints.	Maximum possible discharge subject to S-333 design capacity (1350 cfs) with G-3273 trigger removed.
L-29 constraint	9.0 ft	9.0 ft
S-355A&B	Dry Wet Open 8.50 8.50 Close 6.50 6.50	Dry Wet Open 8.50 8.50 Close 6.50 6.50
S-337	Regulatory releases as per WCA-3A deviation schedule.	Regulatory releases as per WCA-3A deviation schedule.
S-151	Regulatory releases as per WCA-3A deviation schedule.	Regulatory releases as per WCA-3A deviation schedule.
S-335	Open at 7.5; Close at 7.2	Open at 7.5; Close at 7.2
S-334	Same as in 95Base except that it also may pass all or part of S-333 releases to the SDCS, depending on stage at G-3273.	Closed
S-338	Open at 5.8; Close at 5.4. Operated to maximize discharges to coast.	Open at 5.8; Close at 5.4. Operated to maximize discharges to coast.
G-211	Open at 5.7; Close at 5.3.	Open at 5.7; Close at 5.3.
S-331	Start pump at 4.8; pump down to 4.3.	Start pump at 4.8; pump down to 4.3.
S-332B	Pumped up to 500 cfs from Aug through Jan; 325 cfs in Feb, Jun, and July; and 125 cfs from Mar through May. Dry Wet On 5.00 4.70 Off 4.30 4.00	Pumped up to 500 cfs from Aug through Jan; 325 cfs in Feb, Jun, and July; and 125 cfs from Mar through May. Dry Wet On 5.00 4.70 Off 4.30 4.00
S-332B Seepage Reservoir	160 acres with emergency overflow.	160 acres with emergency overflow.
S-332D	Pumped up to 500 cfs design capacity from Jul 16 to Nov 30; 325 cfs from Dec 1 to Jan 31; and 165 cfs from Feb 1 to Jul 15. Dry Wet On 5.00 4.70 Off 4.80 4.20	Pumped up to 500 cfs design capacity from Jul 16 to Nov 30; 325 cfs from Dec 1 to Jan 31; and 165 cfs from Feb 1 to Jul 15. Dry Wet On 5.00 4.80 Off 4.70 4.20
S-332	Closed	Closed
S-175	Closed	Closed
S-194	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20
S-196	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20
S-176	Dry Wet Open 4.85 4.80 Close 4.65 4.70	Dry Wet Open 4.85 4.80 Close 4.65 4.70
S-177	Open at 4.2; Close at 3.6	Open at 4.2; Close at 3.6
S-18C	Dry Wet Open 2.25 2.25 Close 2.00 2.00	Dry Wet Open 2.25 2.25 Close 2.00 2.00
S-197	Same as Test 7 Phase I; Close at 2.3	Same as Test 7 Phase I; Close at 2.3

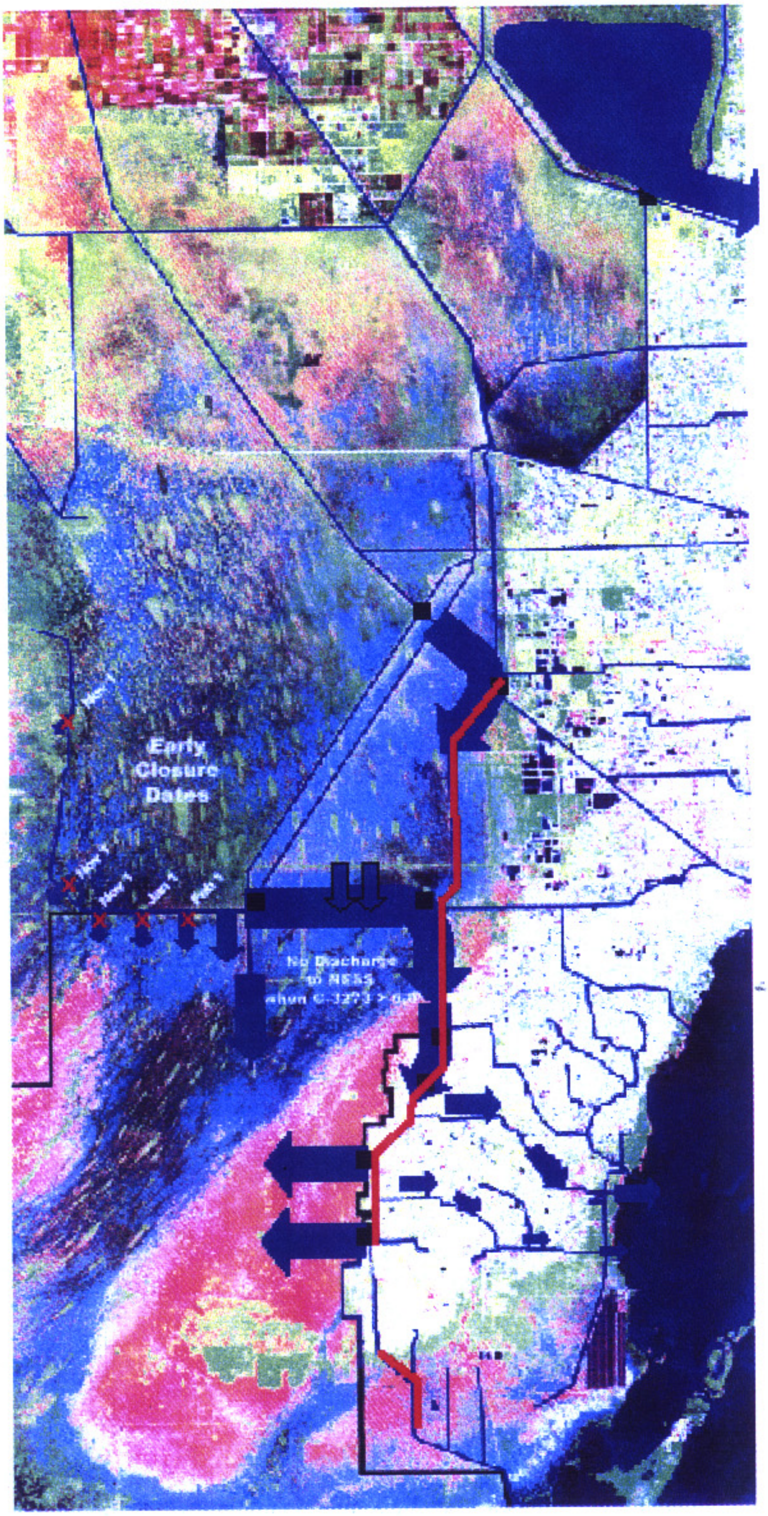


Figure 4.6. Conceptual diagram of operations and flow redistribution under Alternative 5 Phase I relative to Test 7 Phase I.

for Alternatives 1 through 5 in combination with the lower pump capacity is an attempt to provide a more realistic estimate of the benefits indicated by the SFWMM. Pumping at S-332B commences at a higher headwater level relative to the other alternatives **(see Table 4.7)**. Operations at S-332B do not change between Phase I and Phase II. Despite the fact that operations at S-332D are identical to those described in Alternative 5, this pump station appears to accommodate more of the additional regulatory flows from WCA-3A than S-332B under Alternative 6 **(see Figure 4.7)**. Periods of restricted pumping rates are identical to those of Alternatives 1, 3, 4 and 5. Phase I and Phase II operations for S-332D are identical in Alternative 6. Operations at S-176 are identical to those described for Alternative 5. At the same time more of the additional water that enters the SDCS from WCA-3A finds its way into the C-111 basin compared to Alternative 5 **(see Figure 4.6)**. The timing of structure operations along the lower L-31N canal is the same as described above in Alternative 5.

4.3 The Pre-Storm / Storm / and Storm Recovery Operations

The Pre-Storm / Storm / and Storm Recovery Operational in Appendix J draft submitted is a response to the flooding caused by Hurricane Irene as well as the October 2000 storm. However, the objective of this proposal is not explicitly clear. It is an attempt to increase flood protection in south Dade basins, but states that these operations may not prevent flooding and that some areas of the county would flood regardless of canal stages. It has no benefit for the CSSS, and is not analyzed in the EIS.

The proposal refers to basically two conditions or possible events that would initiate the pre-storm drawdowns. The first is an approaching tropical system. This is typically a potential extreme event and to my knowledge ENP has never objected to modifications of C&SF operations prior to events such as this. However, the language needs to be clarified to understand it completely. First it refers to strike probability forecast generated by the National Hurricane Center. Then the SFWMD meteorologist generates an average forecast error "swath" that contains the actual path approximately 60% of the time. This swath is probably about 300 miles wide at 72 hours. This proposal would go into effect when Miami-Dade County is within the swath. It is unclear whether they mean any part of Miami-Dade County or all of it. Nonetheless, it seems reasonable to take advance action to lower canal levels when a tropical system is approaching.

The other event that would initiate pre-storm drawdowns is a quantitative precipitation forecast of 4 inches or more over 3 days. A 3-day, 4 inch rain event is a very common occurrence in Miami-Dade County. Analysis of rain data at Royal Palm that has a period of record beginning in 1949 indicates that there is approximately an 80 % chance of an event such as this occurring in any given year and greater than 50% chance that more than one event such as this will occur. Thus, it seems that this is an extraordinarily low threshold to be used for pre-storm drawdowns. Particularly when compared to an approaching tropical system that can easily drop 10 to 20 inches over three days. It seems incongruous to take the same operational action in response to such different events.

It seems that the past two years, which have contained back to back flood events under significantly different operational rules in south Miami-Dade County, gives us an rare opportunity to

Table 4.7. Summary of operational criteria for Alternative 6 simulation.

	Alternative 6	
	Phase I	**Phase II**
Regulation Schedule	Regulation Schedule Deviation schedule for WCA-3A as specified by USACE including raising Zone D to Zone C from Nov 1 to Feb 11. No deviation in WCA-2A regulation schedule.	Regulation Schedule Deviation schedule for WCA-3A as specified by USACE including raising Zone D to Zone C from Nov 1 to Feb 11. No deviation in WCA-2A regulation schedule.
S-343 A/B and S-344	Closed Nov 1 to July 15 independent of WCA-3A levels.	Closed Nov 1 to July 15 independent of WCA-3A levels.
S-12 A/B/ C/D	S-12A closed Nov 1 to Jul 15; S-12B closed Jan 1 to Jul 15; S-12 C,D closed Feb 1 to Jul 15; Follow WCA 3A regulation schedule after Jul 15	S-12A closed Nov 1 to Jul 15; S-12B closed Jan 1 to Jul 15; S-12 C, D closed Feb 1 to Jul 15; Follow WCA 3A regulation schedule after Jul 15
S-333: G-3273 < 6.8'	55% of the rainfall plan target to NESRS, plus as much of the remaining 45% that the S-12s can't discharge to be passed through S-334; and subject to capacity constraints, which are 1350 cfs at S-333, L-29 maximum stage limit, and canal stage limits downstream of S-334.	55% of the rainfall plan target to NESRS, plus as much of the remaining 45% that the S-12s can't discharge to be passed through S-334; and subject to capacity constraints, which are 1350 cfs at S-333, L-29 maximum stage limit, and canal stage limits downstream of S-334.
S-333: G-3273 > 6.8'	No discharge to NESRS; release 55% of the rainfall plan target, plus as much of the remaining 45% that the S-12s can't discharge through S-333 and S-334, subject to capacity constraints.	Maximum possible discharge subject to S-333 design capacity (1350 cfs) with G-3273 trigger removed.
L-29 constraint	9.0 ft	9.0 ft
S-355A&B	Dry Wet Open 8.50 8.50 Close 6.50 6.50	Dry Wet Open 8.50 8.50 Close 6.50 6.50
S-337	Regulatory releases as per WCA-3A deviation schedule.	Regulatory releases as per WCA-3A deviation schedule.
S-151	Regulatory releases as per WCA-3A deviation schedule.	Regulatory releases as per WCA-3A deviation schedule.
S-335	Open at 7.5; Close at 7.2	Open at 7.5; Close at 7.2
S-334	Same as in 95Base except that it also may pass all or part of S-333 releases to the SDCS, depending on stage at G-3273.	Closed
S-338	Open at 5.8; Close at 5.4. Operated to maximize discharges to coast.	Open at 5.8; Close at 5.4. Operated to maximize discharges to coast.
G-211	Open at 5.7; Close at 5.3.	Open at 5.7; Close at 5.3.
S-331	Start pump at 4.8; pump down to 4.3.	Start pump at 4.8; pump down to 4.3.
S-332B	Pumped up to 250 cfs from Jun through Feb; and 125 cfs from Mar through May. Dry Wet On 5.00 4.70 Off 4.30 4.00	Pumped up to 250 cfs from Jun through Feb; and 125 cfs from Mar through May. Dry Wet On 5.00 4.70 Off 4.30 4.00
S-332B Seepage Reservoir	Seepage Reservoir 400 acres with minimum overflow (if any).	Seepage Reservoir 400 acres with minimum overflow (if any)
S-332D	Pumped up to 500 cfs design capacity from Jul 16 to Nov 30; 325 cfs from Dec 1 to Jan 31; and 165 cfs from Feb 1 to Jul 15. Dry Wet On 5.00 4.70 Off 4.80 4.20	Pumped up to 500 cfs design capacity from Jul 16 to Nov 30; 325 cfs from Dec 1 to Jan 31; and 165 cfs from Feb 1 to Jul 15. Dry Wet On 5.00 4.70 Off 4.80 4.20
S-332	Closed	Closed
S-175	Closed	Closed
S-194	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20
S-196	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20	Operated to maximize flood control discharges to coast Dry Wet Open 4.70 4.70 Close 4.20 4.20
S-176	Dry Wet Open 4.85 4.80 Close 4.65 4.70	Dry Wet Open 4.85 4.80 Close 4.65 4.70
S-177	Open at 4.2; Close at 3.6	Open at 4.2; Close at 3.6
S-18C	Dry Wet Open 2.25 2.25 Close 2.00 2.00	Dry Wet Open 2.25 2.25 Close 2.00 2.00
S-197	Same as Test 7 Phase I; Close at 2.3	Same as Test 7 Phase I; Close at 2.3

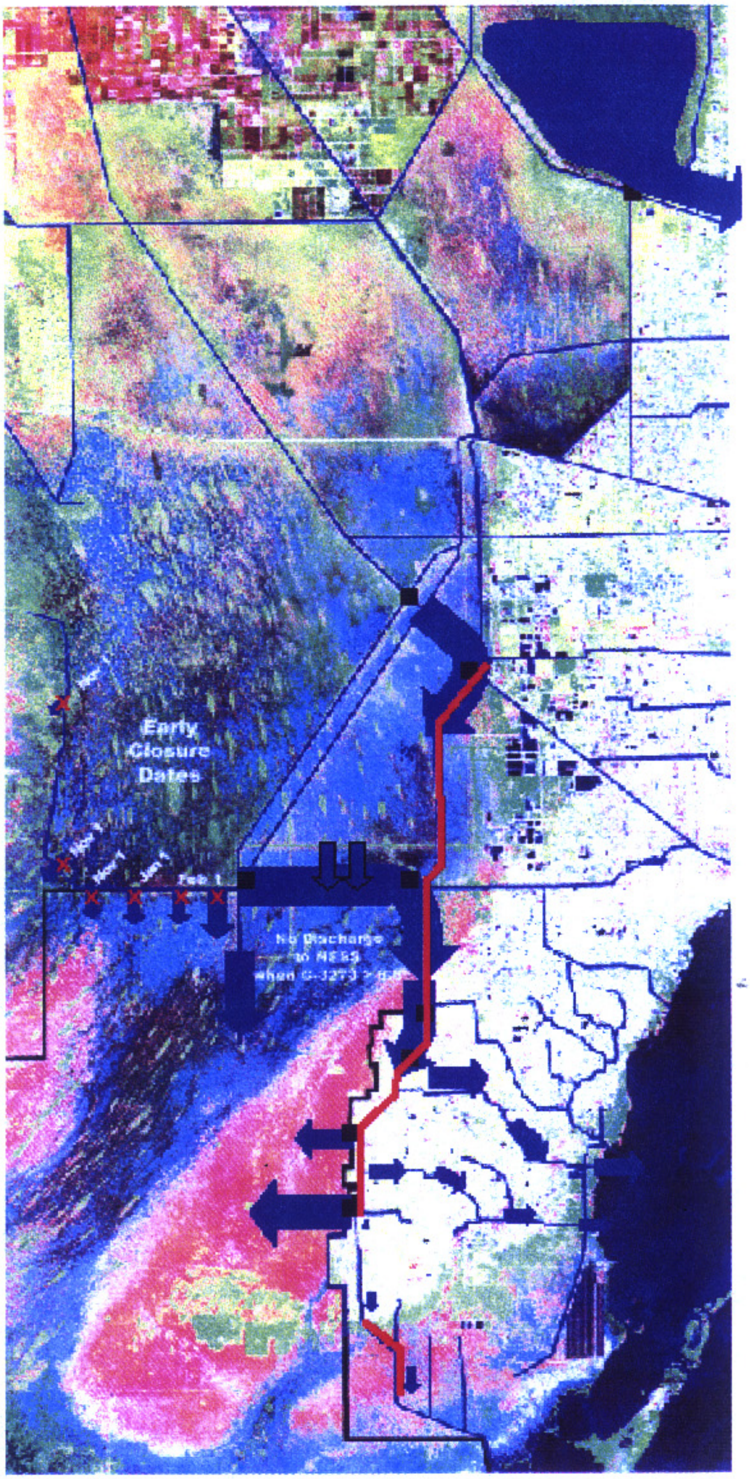


Figure 4.7 Conceptual diagram of operations and flow redistribution under Alternative 6 Phase I relative to Test 7 Phase I.

evaluate the hypothesis, with observed data, that lower canal stages will alleviate flooding from extreme and intense rainfall events.

Starting at the top of the SDCS at S-335 the attached stage comparison plots **(Figure 4.8a)** show that during the 2000 wet season the head water was kept over 2.5 feet lower than in 1999. This operational approach is presumably in response to flooding in Doral and Sweetwater caused by Hurricane Irene and the realization that the Northwest Wellfield Protection Canal is a factor in this flooding. However, even the reduction in the S-335 headwater by over 2.5 feet did not reduce the flooding impact of a similar event, which occurred during October 2000, during much drier antecedent conditions. Thus the hypothesis fails at face value for this structure. That is, it does not appear that reducing S-335 headwater will alleviate flooding in Doral and Sweetwater. It seems more likely that this area is prone to flooding from extreme rainfall events. This contention has been documented for many years in many of the SFWMD's own reports.

Downstream at G-211, the head water was reduced by over 0.5 feet and flooding was still wide spread in west Kendall. However, this could be because while the head water was reduced, massive interbasin transfers were being made through S-335 while attempting to drain Area B into the C-1 and C-111 basins. This practice most likely depleted much of the available storage in the C-1 basin. Unfortunately, validated flow data is not currently available from SFWMD for the structures needed for a more complete analysis. However the hypothesis is supported by the attached plot of the S-338 tailwater and S-148 headwater **(Figure 4.8b)**. While the S-338 tailwater was generally about the same for 1999 and 2000, the S-148 head water appears to be approximately 0.5 feet higher for 2000 than 1999. Keep in mind, the 2000 wet season was substantially drier than the 1999 wet season.

Lower in the system, the attached plots of S-18C headwater and S-177 headwater **(Figure 4.9)** do not show significant differences in operations between 1999 and 2000. However, again, since 2000 was drier than 1999, one would expect lower water levels. It seems that SFWMD took advantage of the dry early wet season and practiced massive basin transfers. Unfortunately, the October 2000 event revealed the negative aspects of this practice.

Impacts to the hydrologic resources of ENP from implementation of a plan such as this will certainly include water losses through seepage along the Eastern boundary. Thus, this proposal will impact water depths in NESS and the Rocky Glades. The magnitude of the impact is difficult to assess. Depending on antecedent and subsequent conditions, this proposal could also impact hydroperiods along the eastern side of ENP and in WCA-3B.

Basic, steady groundwater flow calculations based on the water level profile depicted in the attached plot entitled "Water Surface Profiles Rocky Glades Transect" **(see Figure 4.51)**, indicate that lowering the canal stage by 0.5 feet in a very short period of time can increase the ground water gradient by 41 percent. Of course, since groundwater flow velocity is directly proportional to the gradient, it is reasonable to conclude seepage will also increase by 41 percent. Using fairly conservative estimates of hydraulic conductivity (12,500 feet squared per day) (USACE 1953), aquifer depth (60 feet) and the 30 mile length of SDCS between US41 and S-18C, the **increase** in seepage out of the natural areas would be on the order of 100 acre-feet per day. Thus, if a proposal such as this is implemented, we request make up water should be pro-

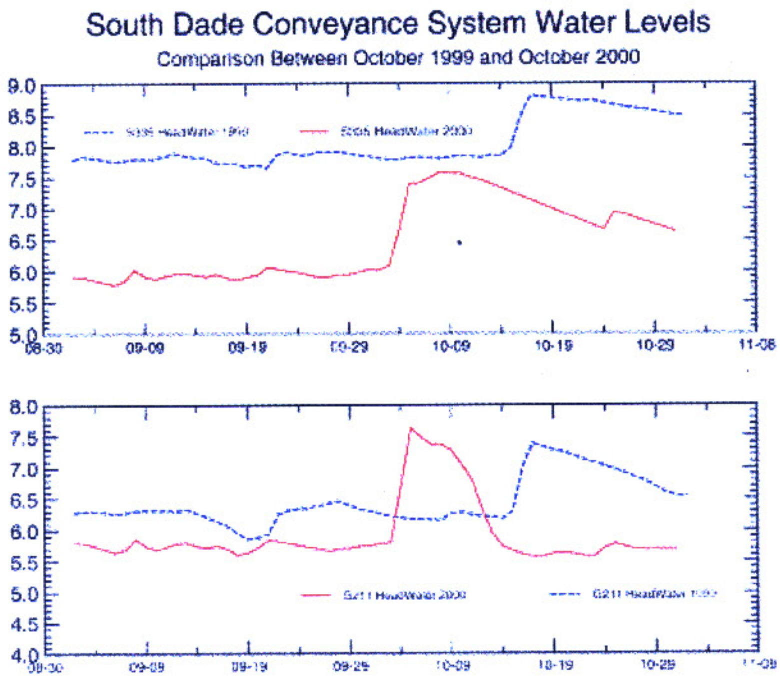


Figure 4.8a Operational levels at S-18C and S-177 for Oct 1999 and Oct 2000.

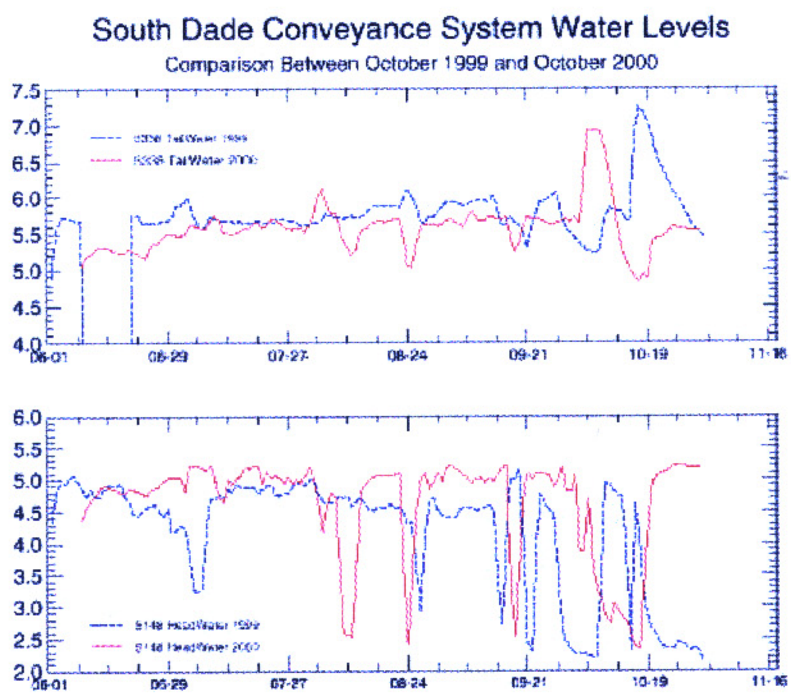


Figure 4.8b. Operational levels at S-338 and S-148 for Oct 1999 and Oct 2000.

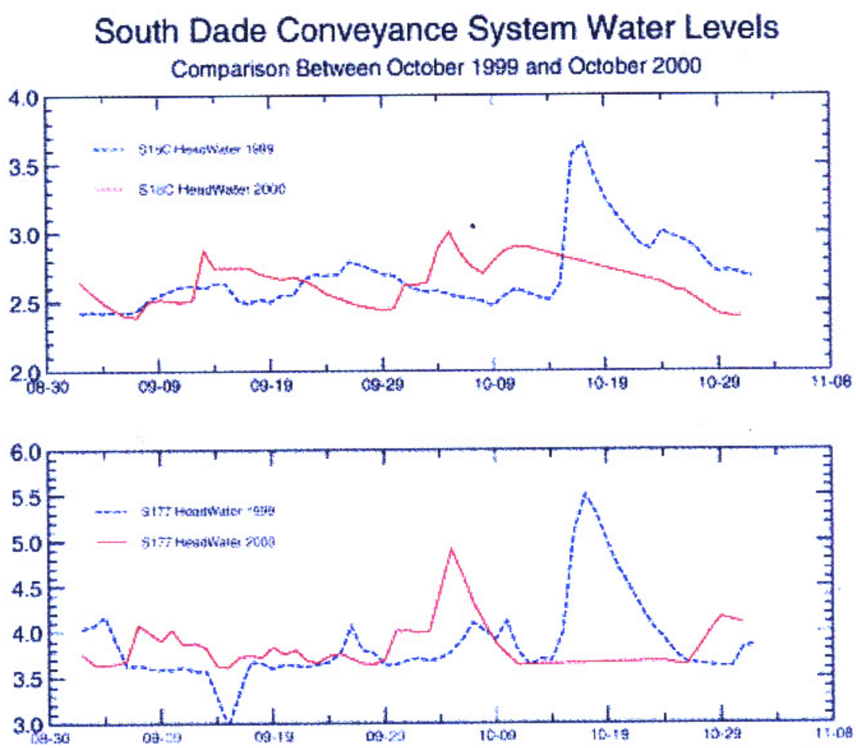


Figure 4.9. Comparison of South Dade Conveyance System Headwater Levels at S-18C and S-177 for October 1999 and October 2000.

vided to NESS and Rocky Glades directly after the storm has passed.

4.4 Modeling of ISOP

Models of the ISOP were prepared by the Corps and ENP. The primary tool used for evaluating the ISOP plan was the SFWMM version 3.8. The SFWMM simulation representing the ISOP2000 operations is called ISOP9D. The model runs provided by the Corps to represent the ISOP evolved from ISOP9D to ISOP9DR. ISOP9D and ISOP9DR differ in the following ways:

- ISOP9DR does not include deviations from the WCA-2A regulation schedule that are proposed in ISOP9D.
- ISOP9DR closes S-12A on November 1 instead of Jan 1.
- ISOP9DR S-332B is pumping is limited to 125 cfs from February-May
- ISOP9DR raises the S-176 close criteria to 4.5 feet.

While most of the SFWMM output related to the ISOP is ISOP9DR, the MODBRANCH analysis was based on the ISOP9D model run.

Because the Corps has identified the ISOP2001 operations as the no action alternative for the

IOP, some figures may refer to the ISOP9DR run as the "No Action" simulation. Results from the SFWMM indicate that the ISOP would decrease hydroperiods in NWSS and NESS while increasing hydroperiods in eastern ENP in the Rocky Glades, Taylor Slough and the Eastern Marl Prairies **(Figure 4.10)**. According to the SFWMM the ISOP reduces hydroperiods in NWSS in a "1-in-10" wet year **(Figure 4.11)** as well as in a one in ten drought **(Figure 4.12)**. The ISOP simulations indicate that hydroperiods are greater in the Rocky Glades for both wet and dry con-

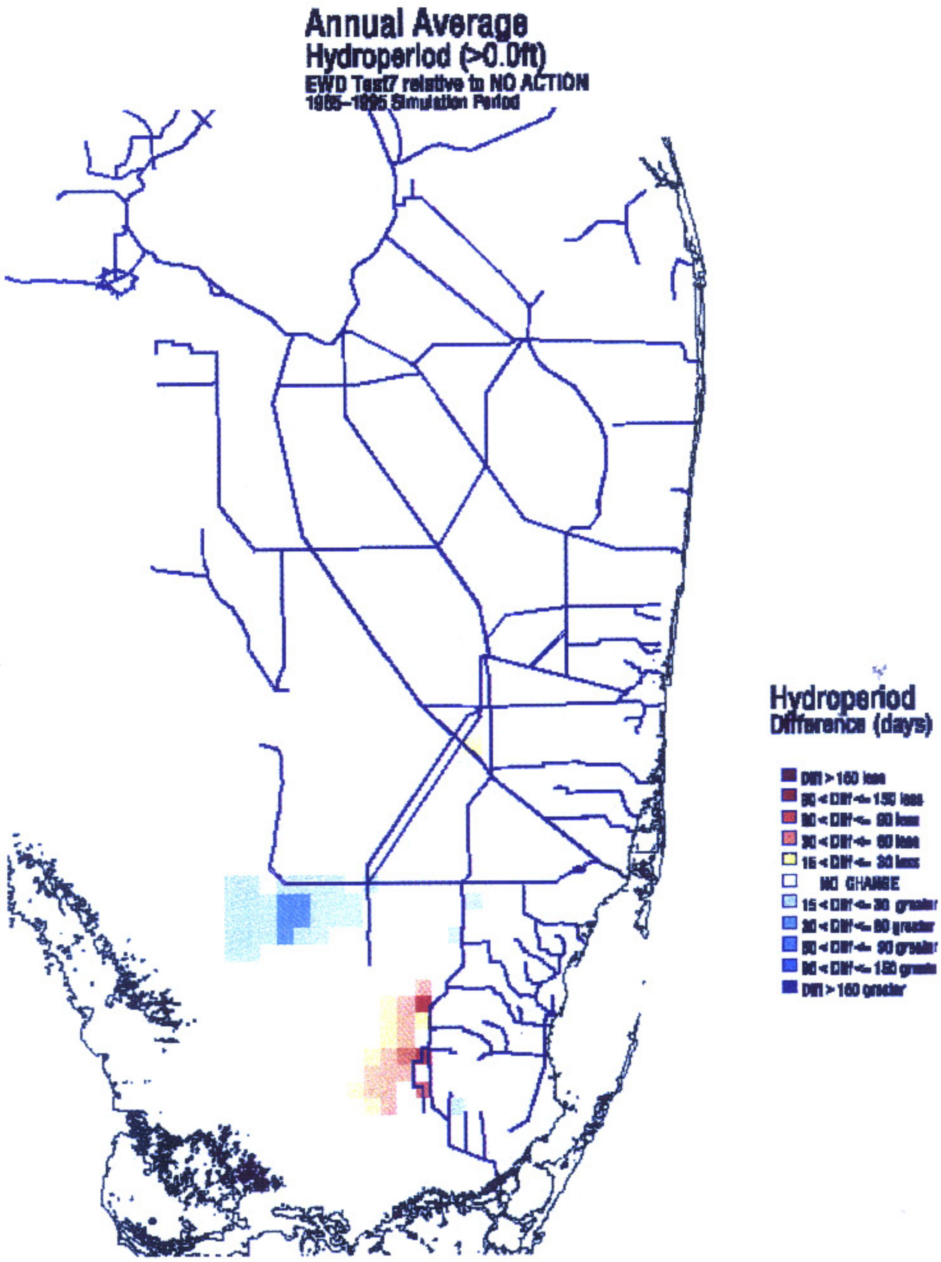


Figure 4.10. Modeled average annual hydroperiod difference (Test7I-ISOP)

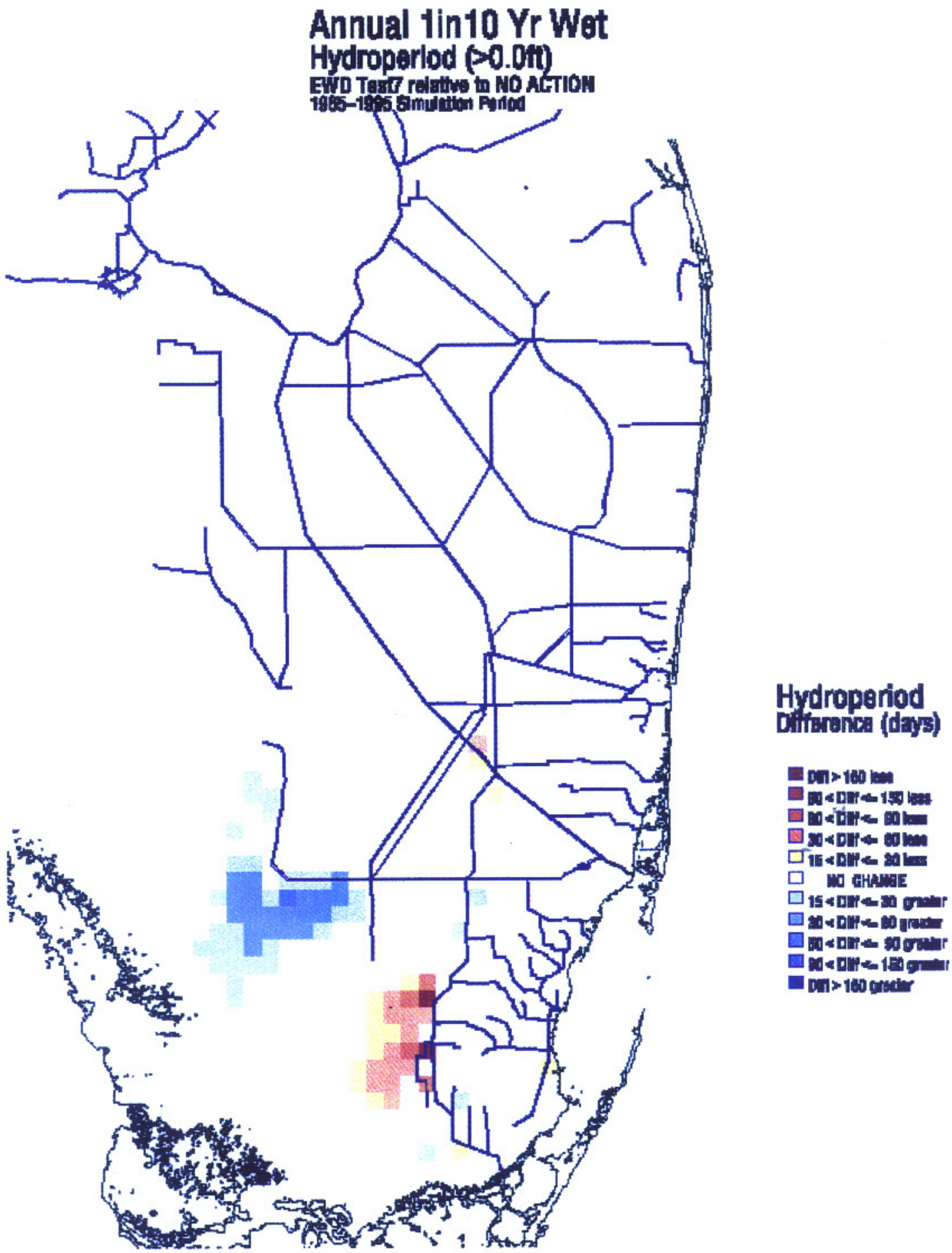


Figure 4.11. Modeled hydroperiod difference (Test7I- ISOP) for “1-in-10” wet year.

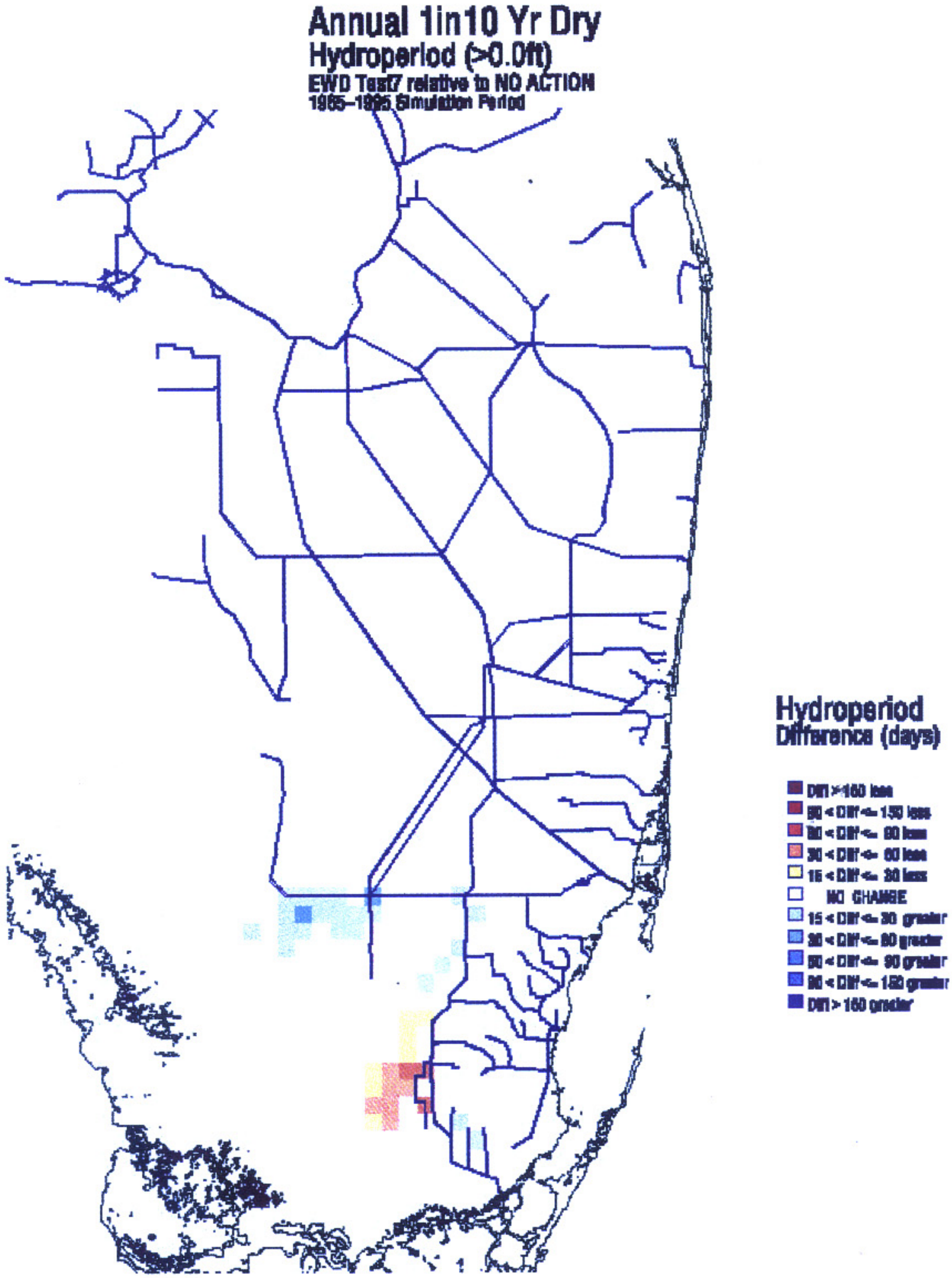


Figure 4.12. Modeled hydroperiod difference (Test7I - ISOP) for "1-in-10" dry year

ditions. The model predicts decreases in both wet and dry season average overland flows to ENP on the Western side of L-67 extension, while overland flows are slightly reduced across the Eastern side of L-67 extension **(Figure 4.13)**.

The ISOP was designed to provide the hydrologic equivalent of the RPA. Several SFWMM runs were designed to simulate the RPA. Prior to the simulation of a single RPA two were simulated; one for the western CSSS habitats and for the eastern CSSS habitats. RPA102 simulates the necessary habitat improvement for sub-populations F, C and D. RPA130 simulates the necessary habitat improvement for sub-populations A and E. Model results shown in **Figure 4.13** indicate significantly more overland flow in NESS from the RPA than from the ISOP. While the RPA provides increased flow to sub-populations E and F by moving water through NESS, the ISOP seeks to provide an equivalent benefit by moving water down the L-67 extension canal, and through pumping at S-332B and S-332D on the eastern side of ENP **(Figure 4.14)**.

In addition to the SFWMM, we have simulated the RPA and ISOP operations with the MODBRANCH and the GFLOW models. The MODBRANCH modeling was conducted to provide more detailed understanding of the effect of the new S-332B pump station and detention basin on the Eastern CSSS Habitats. The GFLOW modeling was conducted to assess the effect of the

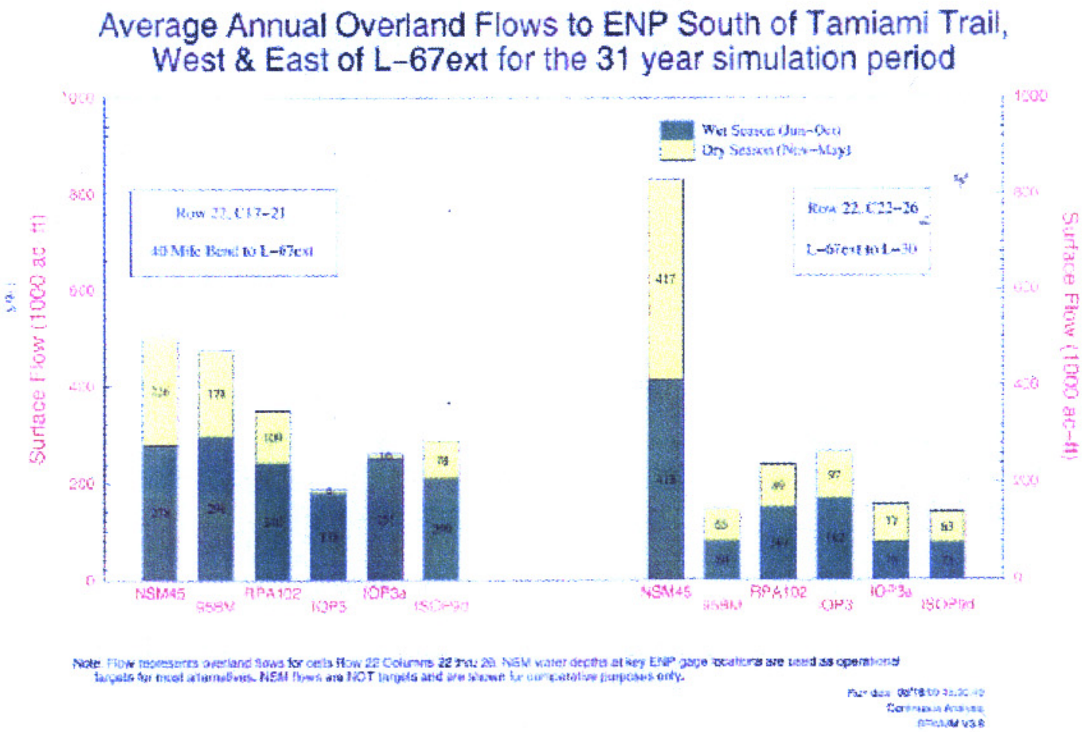


Figure 4.13. Modeled overland flows to Shark Slough.

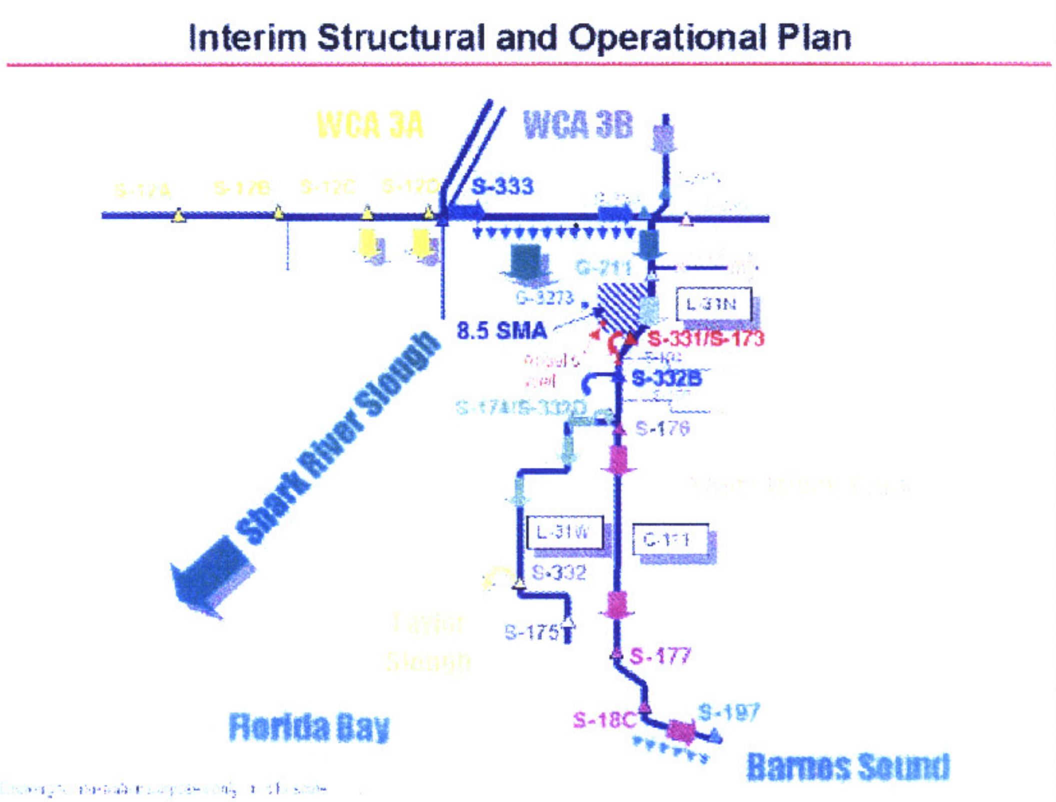


Figure 4.14. Diagram of structural operations for ISOP2000 (USACE).

2 mile grid discretization on the groundwater flow field, in the vicinity of S-332B.

4.4.1 MODBRANCH Modeling Results

Preliminary MODBRANCH simulations were made in order to determine the potential impact of S-332B. The initial simulation focus was on modeling of two alternatives: RPA101 and ISOP9D. In order to investigate the hydrology of the ISOP alternative and the RPA at a smaller scale than the SFWMM, a MODBRANCH model was constructed. The MODBRANCH model was derived from an existing model of the region, developed by the Corps (USACE, 2000). Changes were made in the operating rules of the model to reflect changes and operating rules of ISOP9D and RPA101. Changes were also made in the BRANCH portion of the model to add the pumps, delivery channel and detention basin for S-332B. Boundary conditions along the northern and western edges of the model were extracted from the SFWMM. Starting heads for each model run were also extracted from the SFWMM model. The MODBRANCH model was run for a single year using the water withdrawals and meteorology (rain, evapotranspiration) for 1995. Additional changes were made in the operation of the G-211 and S-331 structures in order to more realistically model the operations in L-31N. These model simulations should be viewed as preliminary and serve primarily as a means to evaluate the effect of model scale on the flow in the vicinity of S-332B. Further calibration of the model is needed to ensure that the operations in L-30 and L-31N are represented appropriately.

In the following analysis, it is important to keep in mind that both the SFWMM and the MOD-BRANCH model produce results that are rough estimates of the actual flows and water levels that might result from these operations. Each model simulation has a considerable amount of uncertainty relative to the observed conditions. Comparing model results for one alternative to another provides a method for assessing the relative hydrologic benefits and impacts between alternatives and should have less relative uncertainty. Comparing MODBRANCH results to SFWMM results provides a method for assessing the effect of the model itself. In this application, the primary objective in comparing MODBRANCH and SFWMM results is to assess the effect of the coarse resolution of the SFWMM in the vicinity of S-332B.

Comparison of the average ponding depths from both the SFWMM and MODBRANCH for ISOP9D and RPA101 reveals the effect of the model resolution. An essential component of ISOP9D is the S-332B pumping station and retention basin. The retention basin is a ½ x ½ mile basin. Since the SFWMM grid cell size is 2 x 2 mile, the retention basin is necessarily larger in the SFWMM than it is in actuality. The effect of spreading the higher stages that occur in the retention basin over twice the area is to disperse the impact of the retention basin. As a result, the SFWMM may overestimate the benefit of the retention basin in raising water levels in the some of the eastern CSSS habitats. Actual operation of the structure has shown that pumping to S-332B is limited by the ability to infiltrate water into the limestone aquifer. Because of water quality concerns, the water level in the retention basin should not be allowed to overflow the sill, limiting stages in the retention basin to approximately 8 feet. These constraints on infiltration and stage lead to actual sustainable maximum pumping rates of about 130 cfs. In the SFWMM v 3.81 ISOP9D run, S-332B pumps an average over the entire simulation of 260 cfs into the S-332B retention basin and during the 1995 model year an average of 325 cfs is pumped into the retention basin. This overestimation of the pumping capacity at S-332B could also lead to an overestimate of the benefit of the retention basin in raising water levels in the eastern CSSS habitats.

In the MODBRANCH simulation of ISOP9D, the pumping at S-332B is constrained by the stage in the aquifer below S-332B retention basin. This has the effect of limiting the average flow for the 1995 model run to 156 cfs and so produces a more realistic estimate of the effectiveness of S-332B in raising water levels in eastern CSSS habitats.

In the MODBRANCH model, the effect of S-332B is evident when comparing ISOP9D and RPA101 **(Figure 4.15)**. The average increases in water levels occur mostly in CSSS habitat F. The area of increased water levels is approximately 18 square miles, which is 6 square miles smaller than the impact predicted by the SFWMM **(Figure 4.16)**. The maximum increase in water levels due to ISOP9D occurs during week 40 (October 1-7) of 1995 and cover the southern portion of sub-population F **(Figure 4.17)**. In 1995, increased water levels due to S-332B do not extend to CSSS habitat E. Smaller increases in water depth seen in sub-populations C and D are

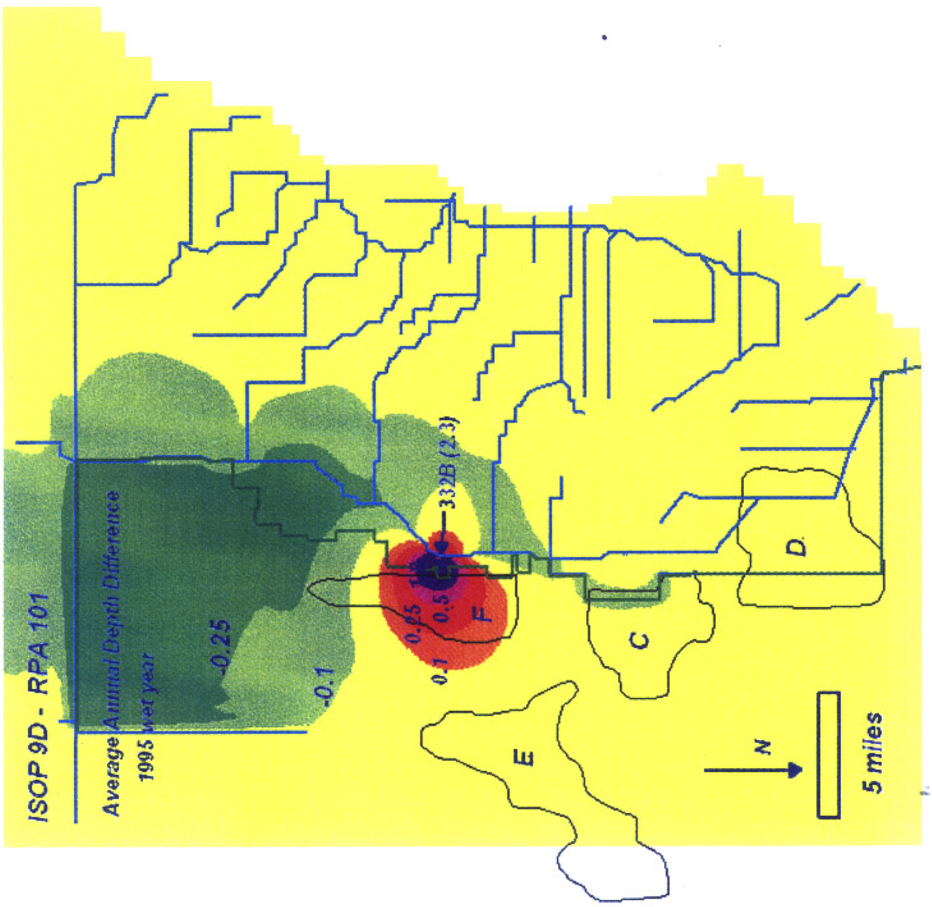


Figure 4.15. MODBRANCH model average annual depth difference (ISOP9D – RPA101) for a 1995 wet year.

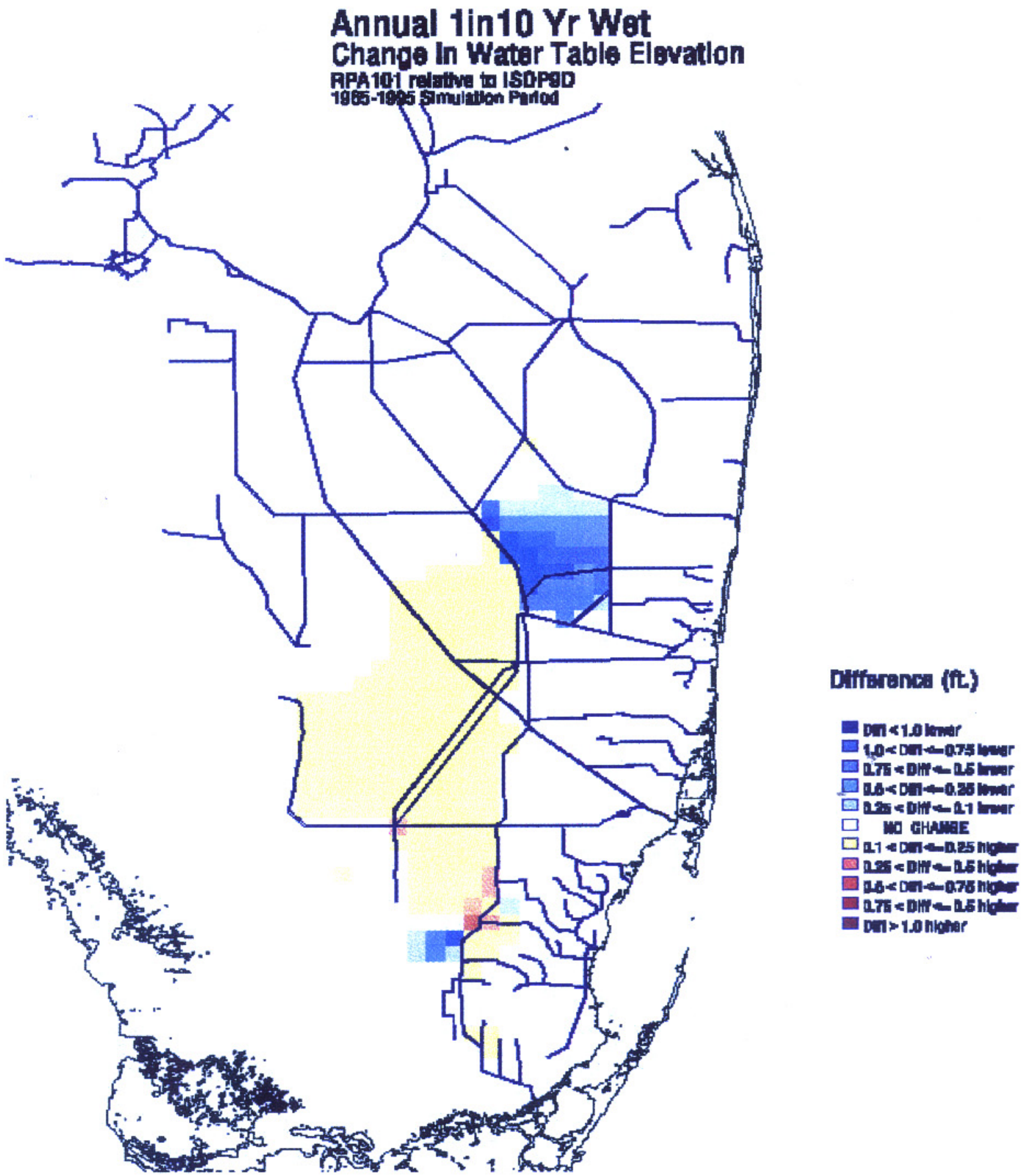


Figure 4.16. SFWMM model average annual depth difference (RPA101 – ISOP9D) 1995 wet year for a "1-in-10" wet year.

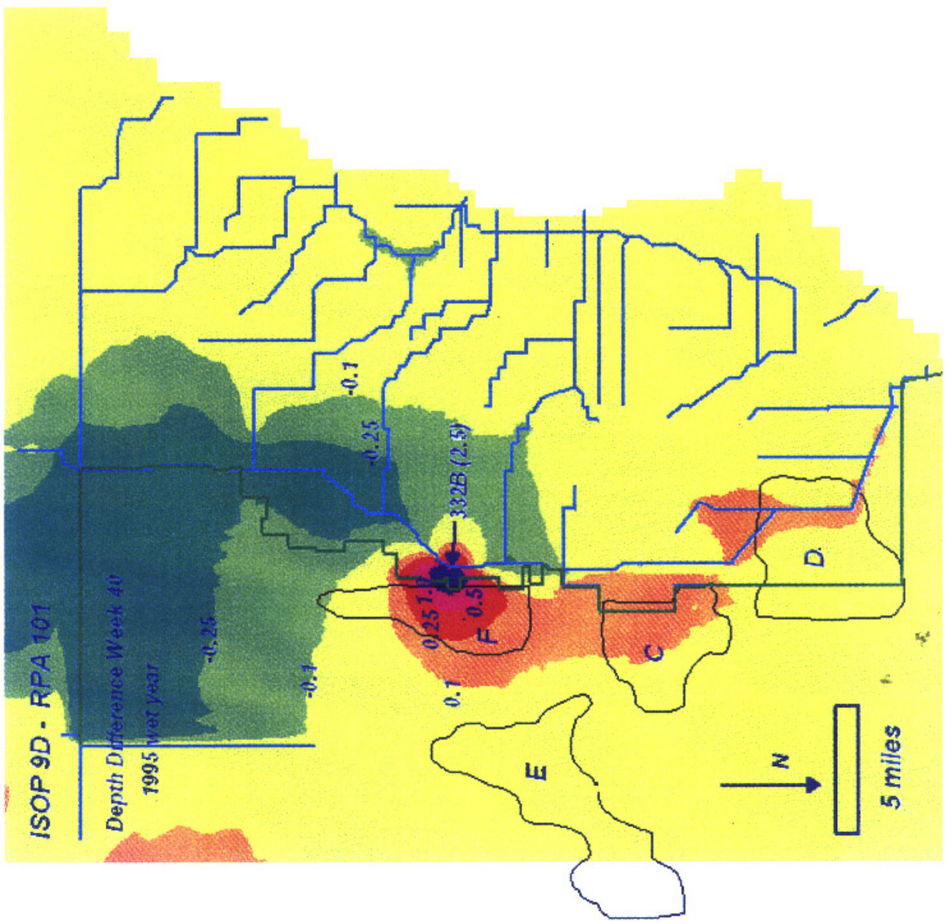


Figure 4.17. MODBRANCH depth difference for week 40 (ISOP9D-RPA01) 1995 a wet year.

most likely caused by operational changes other S-332B. In ISOP9D open and close criteria for S-176, S-194, S-196 and S-18C are lowered. By the end of 1995 the impact of ISOP operations is seen in sub-populations C and D, where water levels in ISOP9D are as much as 1 feet lower than RPA101. Changes in water levels observed in sub-population C are due primarily to reduced discharge through S-332D **(Figure 4.18)**.

Hydroperiods from the MODBRANCH model **(Figure 4.19)** give some indication of the effect of the proposed alternative on CSSS habitat during a wet year. Hydroperiods in the range of 180-365 days may cause a shift to vegetation unsuitable for CSSSs during average years, but might be acceptable in a wet year. Most importantly, these graphics give an indication of the importance in considering the local gradients in topography and stage when determining CSSS habitat suitability.

The MODBRANCH model runs of the 1995 year suggests:

- Operations at S-332B should result in increased average water depths over half of CSSS sub-population F during a wet year such as 1995.
- Increases in attainable water levels and hydroperiods due to S-332B pumping may be overestimated in the SFWMM.
- Increased water levels at S-332B may cause portions of CSSS habitat F to become too wet to support the appropriate vegetation for CSSS habitation.
- Reduced open and close criteria in the L-31N/C-111 basin cause early dry season decreases in water levels in CSSS habitats C and D.

4.4.2 GFLOW Model

The version of the SFWMM used to simulate ISOP9D (v3.81) included special code modifications to enable the SFWMM to simulate reservoirs such as S-332B that are smaller than the grid size of the model. This version of the model was applied without further calibration, verification or documentation to produce the ISOP9D and other model runs. In a March 2 letter **(see Appendix A)** to Sherry Mitchell-Bruker from Ken Tarboton of the SFWMD, it is stated that "the SFWMM should not be used to estimate water levels in the retention area on a daily basis, nor the magnitude or frequency of expected spillover from the retention area into the CSSS habitat on a daily basis. It is however very appropriate to use the SFWMM as a planning tool for longer term hydrologic quantification such as weekly average pumpage into the retention area, spillover from the retention area, and weekly to annual or long term (31-year) average impacts on the CSSS habitats."

We contend that this lack of local detail in the SFWMM could lead to erroneous conclusions in several ways:

1. Failure to accurately calculate seepage out of the retention area into the L-31N canal could occur as a result of errors in simulating the gradient between the reservoir and the canal. This error would likely result in an underestimation of seepage and an overesti-

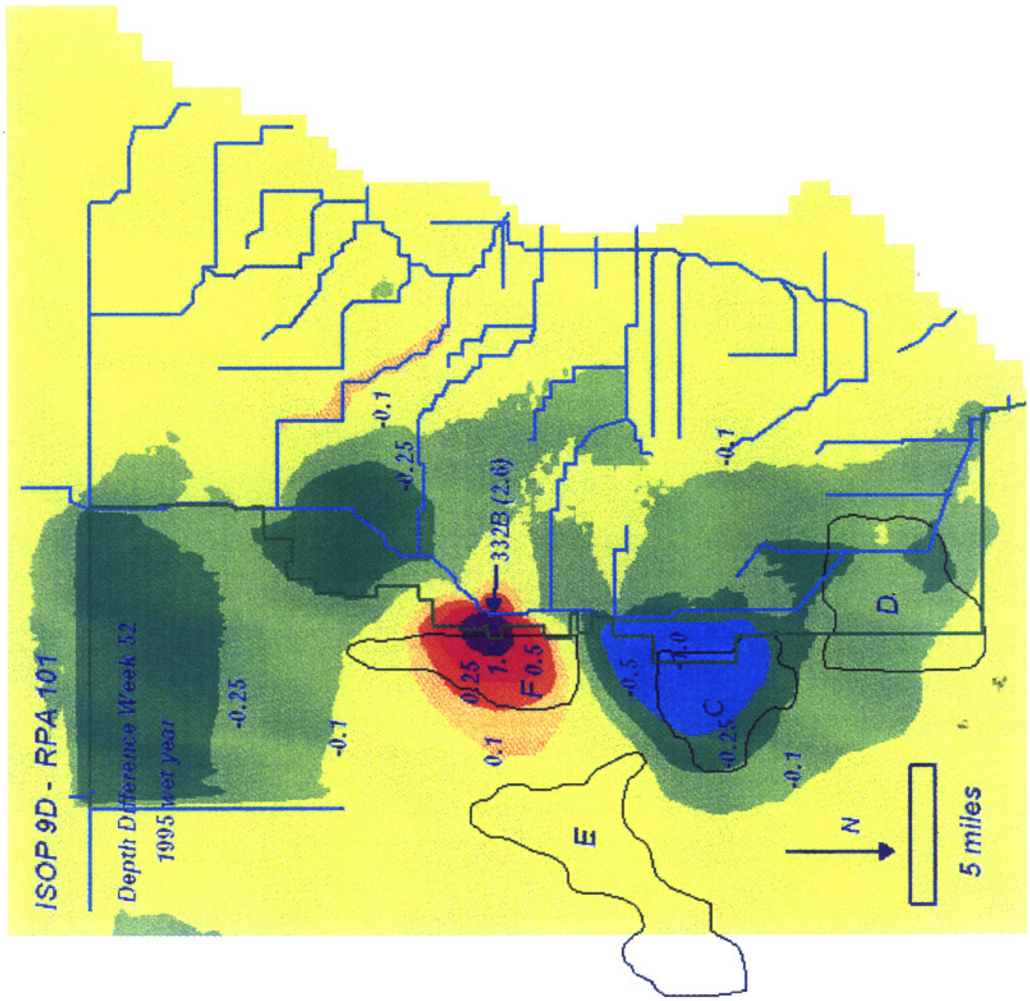


Figure 4.18. MODBRANCH depth difference for week 52 (ISOP9D-RPA101) 1995 a wet year.

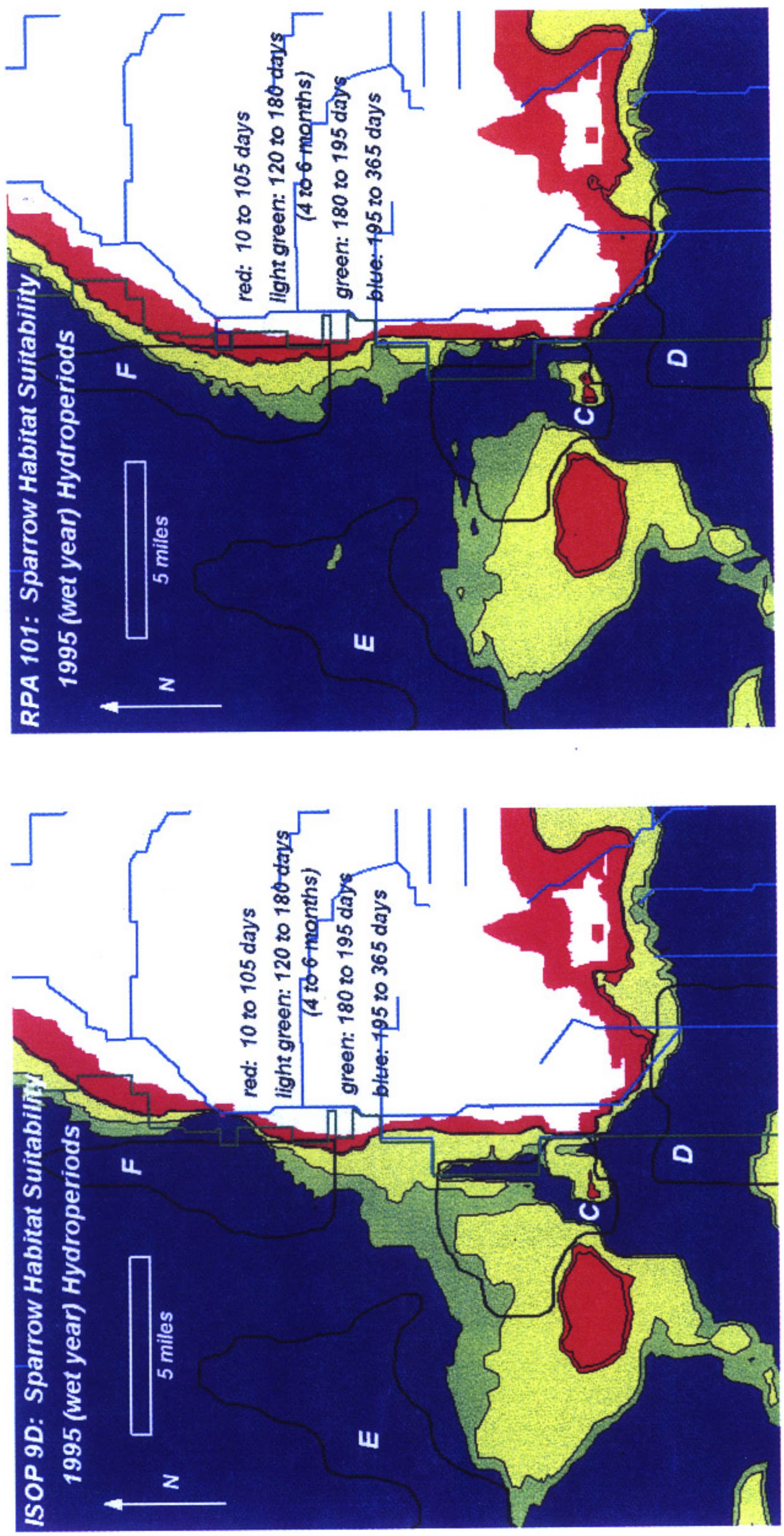


Figure 4.19. MODBRANCH hydroperiods for ISOP9D and RPA101 1995 a wet year. Areas in green are may provide suitable sparrow habitat.

mation of available storage in the reservoir. Since the reservoir was built as a receiving body for regulatory releases from WCA-3A, overestimation of available storage could mean undersizing of the retention area and underestimation of overflow into ENP.

2. Even if the undocumented special code used in the SFWMM were to accurately calculate the seepage, the resultant flux into the groundwater would be spread over a 4 square mile area and is not likely to be accurately distributed between the aquifer and the canal. This error could manifest itself as inaccurate estimates of water depths and hydroperiods in CSSS habitat.

3. If we were to assume that the model performs adequately with respect to items 1 and 2, then the stage, topography and water depth gradients that occur within cells would be used to compute an average water depth over the cell, which would then be used to calculate hydroperiods in CSSS habitat indicator regions. In the region of S-332B, there are steep hydrologic gradients that run counter to the topographic gradient, creating even steeper depth gradients. Averaging water tables and topography in this area could lead to a failure to detect excessive flooding or drying of CSSS nesting areas.

We conducted a series of model runs using the GFLOW (Haitjema 1995, Mitchell-Bruker and Haitjema, 1995) model to demonstrate the error in simulating groundwater flows from a reservoir that is smaller than the model grid cell (item 2). The GFLOW model is a steady state analytic element groundwater model. The value of using the GFLOW model in this exercise was the ease of implementation and more importantly, the absence of grid discretization errors. Because the solution to the GFLOW model is analytic, there is no grid or mesh. Comparisons of both GFLOW and MODBRANCH models to actual field data reveal that both models are capable of more accurately simulating the local stage variations that occur near the S-332B retention basin **(Figures 4.20, 4.21 and 4.22)** than the SFWMM. According to Tarboton (personal communication) "the 2-mile by 2-mile scale of the model [SFWMM] may not capture field-scale variability within a single cell".

Figure 4.23 is a stage contour plot for September 9, 2000 for much of the uplands of eastern ENP. **Figure 4.24** is a stage contour plot for the same date calculated by the GFLOW model. This single layer groundwater flow model is able to capture the flow patterns and gradients of the tightly-linked aquifer/marsh/canal system characteristic of the area. Because of the high permeability of the aquifer, the groundwater and surface water regimes are tightly coupled and the transient hydrologic system comes quickly to equilibrium and so can readily be modeled as a series of successive steady states (Townley 1995). Likewise, because of the dense vegetation and slow tortuous flow path in the marsh, the surface water flow can be approximated as a highly permeable aquifer. Strack (1981) has demonstrated that aquifer layers of varying hydraulic conductivity can be modeled as a single layer using the concept of a comprehensive potential and a comprehensive hydraulic conductivity. Although it would be reasonable to argue that this model is not appropriate for use in predicting surface water flows, it seems to provide a fairly accurate simulation of the local water level gradients in the vicinity of the S-332B detention basin, which is more than adequate for the purposes of this exercise.

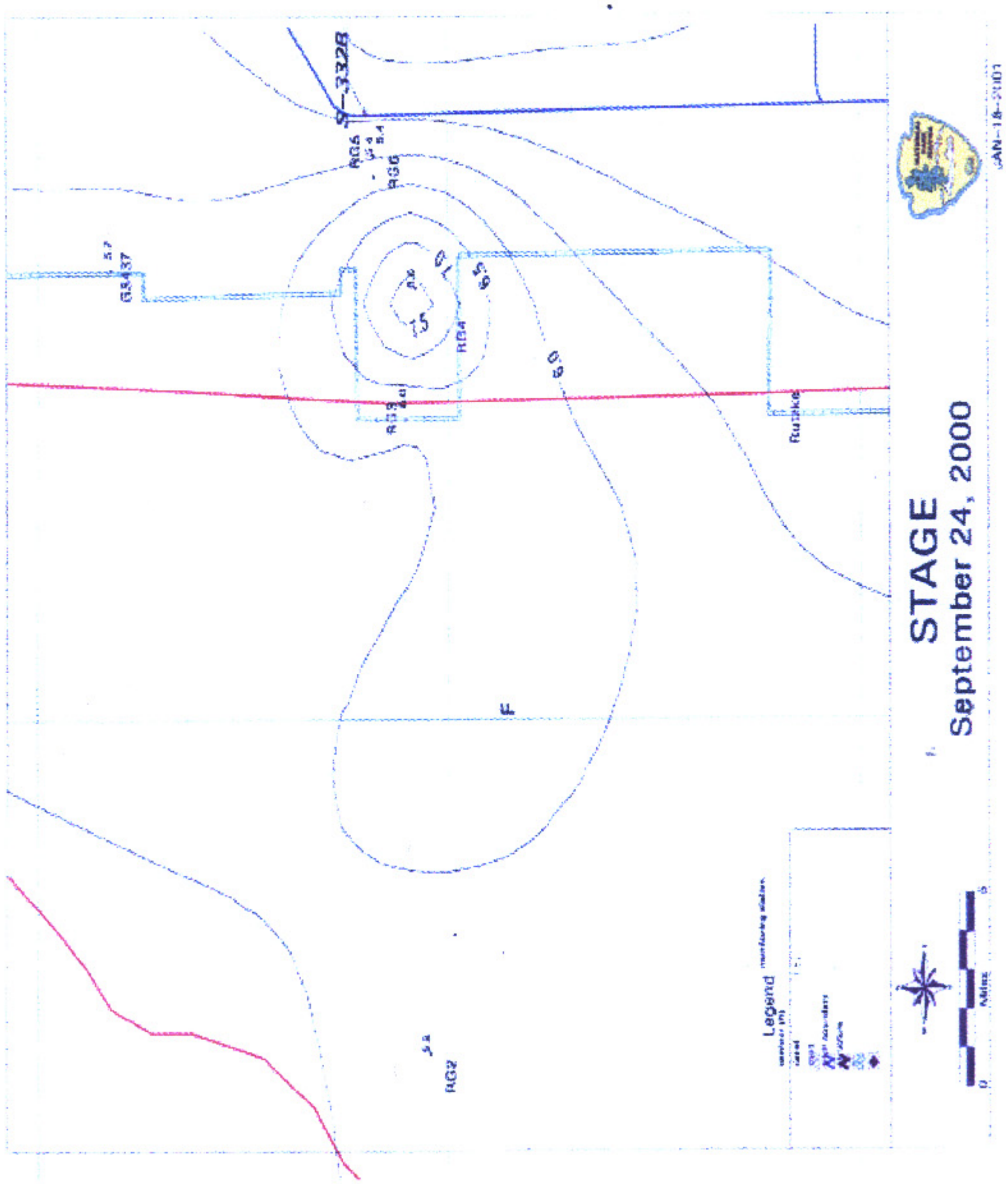


Figure 4.20. Contour map of measured water levels for September 24, 2000 when S-332B is full.

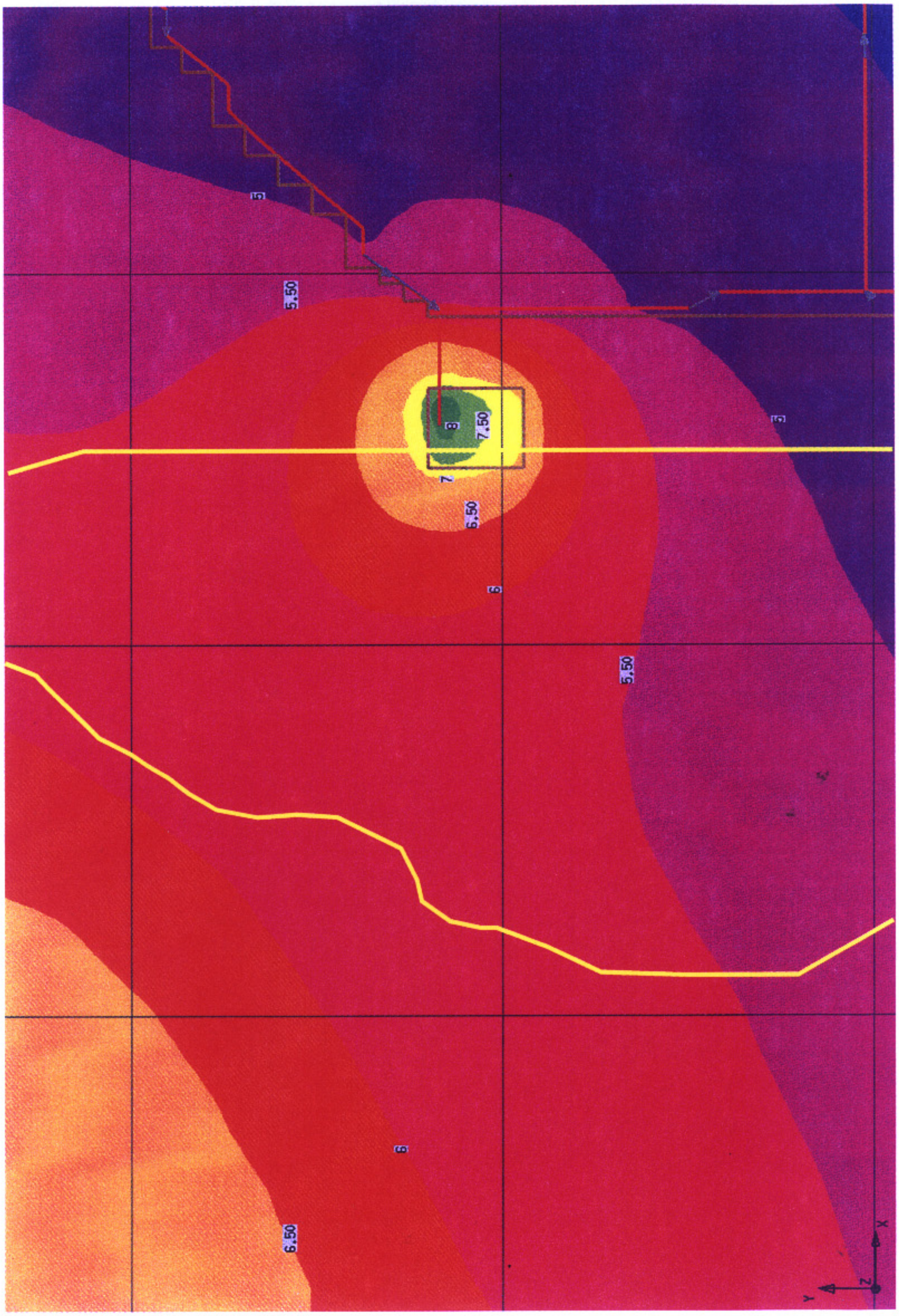


Figure 4.21. Water level contours from MODBRANCH model with SFWMM grid overlay. CSSS Sub-population F habitat indicated by yellow outline

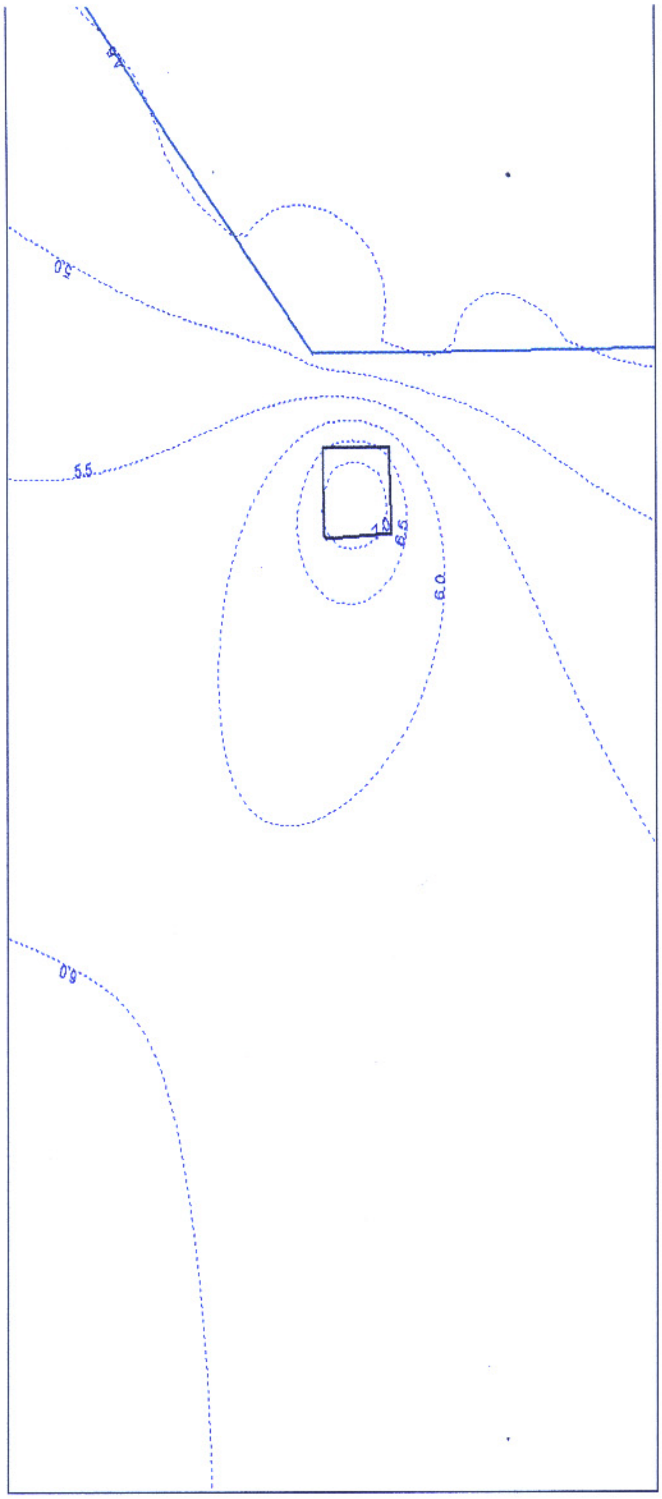


Figure 4.22. Water level contours for September 24, 2000 from GFLOW model.

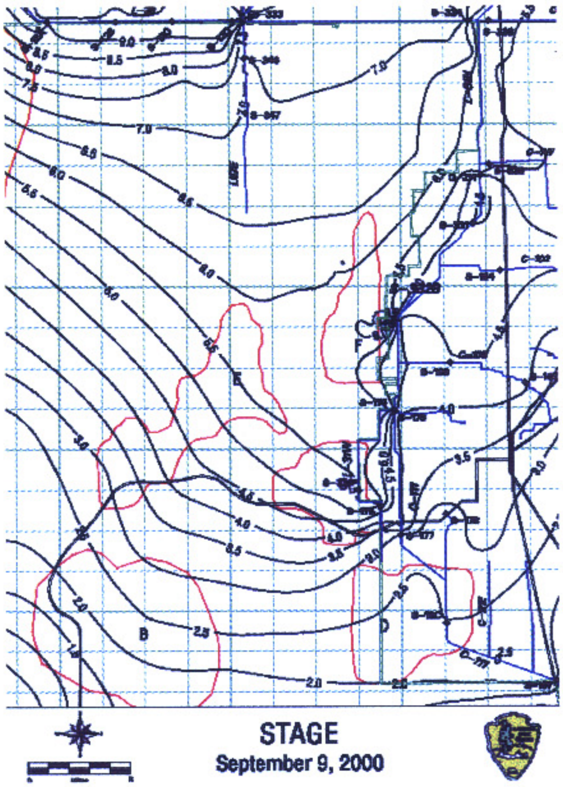


Figure 4.23. Contour map of measured water levels, September 9, 2000 .

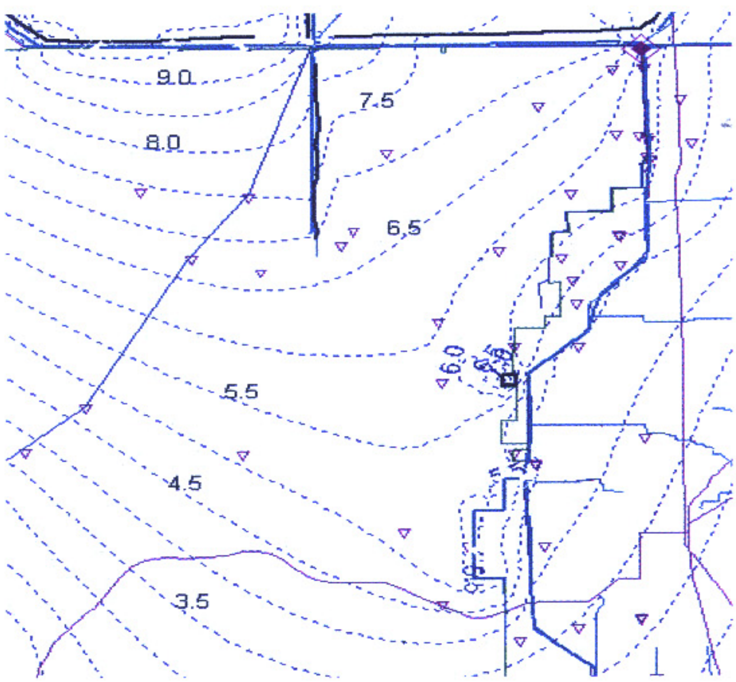


Figure 4.24. GFLOW modeled water level contours for September 9,2000.

To simulate the S-332B detention basin, a source inhomogeneity was distributed over the area corresponding to the 332B detention basin. The recharge rate to the aquifer was increased to provide a head in the aquifer below the retention basin of 8 feet National Geodetic Vertical Datum (NGVD). The recharge rate corresponding to this stage was 3.5 feet/day which would correspond to an input over the 0.25 square mile retention basin of 282 cfs, however field data indicates a sustainable pumping rate and of about 130 cfs. Geophysical data from Corps indicates a thin layer of low permeability material near the soil surface which may restrict infiltration. Further evidence of the influence of this low permeability layer is the steep gradient that is observed between the water surface in the retention basin and the RG3 well, just outside the retention basin. When the retention basin stage is at 8 feet, RG3 is at 6.0 feet. If we adjust the modeled recharge rate to 1.6 ft/day, corresponding to the 130 cfs, we obtain a stage outside the retention basin of 6.2 feet, which we have accepted as a reasonably good representation of the S-332B retention basin for this exercise **(Figure 4.25)**.

One question we are asking is this. If we assume that the special code for the SFWMM perfectly calculates the appropriate amount of seepage from the S-332B basin and applies that amount of seepage evenly over a 2x2 mile cell, then how does that discretization affect the groundwater solution? We answer this question in the following way. The 4 square mile cell is 16 times larger than the 0.25 square mile retention area. Therefore we divide the 1.6 ft/day recharge rate by 16 and apply 0.1 ft/day recharge over a 4 square mile area that is located at approximately the same location as the SFWMM model cell representing the S-332B retention area. The results of this solution are shown in **Figure 4.26**. Since the SFWMM applies a constant head to a cell, we will changed the retention basin from a recharge specified element to a constant head condition, represented by strings of linesinks. A specified head of 6.1 feet was determined by using the computed head on a grid of 25 points within the 4 square mile retention basin to calculate the average head in the 4 square mile retention basin. Comparing this solution **(Figure 4.27)** to the 0.25 square mile retention basin **(Figure 4.26)**, we see that the discretization error leads to overestimating heads by as much as 1 feet. Of the points we tested, the error is greatest at G-3437 (0.98 feet) and least at NP-206 (0.22 feet). These results confirm that the errors associated purely with the model cell size can lead to overestimation of water levels in CSSS habitat. This is the error associated with item 2. Likewise, there will most probably be additional errors associated with items 1, and 3.

The GFLOW analysis, along with the MODBRANCH analysis and the measured gradients in the vicinity of the S-332B detention area lead us to conclude that additional modeling that provides for more accurately representation of the local gradients and topography would lead to more accurate predictions of CSSS nesting opportunity and discontinuous hydroperiods in the CSSS sub-populations. In fact, recent communications from the SFWMD (Santee, pers. Comm.) indicate that a check on the calibration of the SFWMM v3.81 revealed errors that would lead to overestimating the seepage out of L-31N, and the model was deemed unreliable. Therefore the older version of the SFWMM (v 3.8) without special code to simulate small reservoirs was used for the most recent simulations of the ISOP9DR. We would anticipate that the errors related to the coarse grid would be even greater using this version of the model, which would calculate seepage based on the average stage in the cell rather than the stage in the deten-

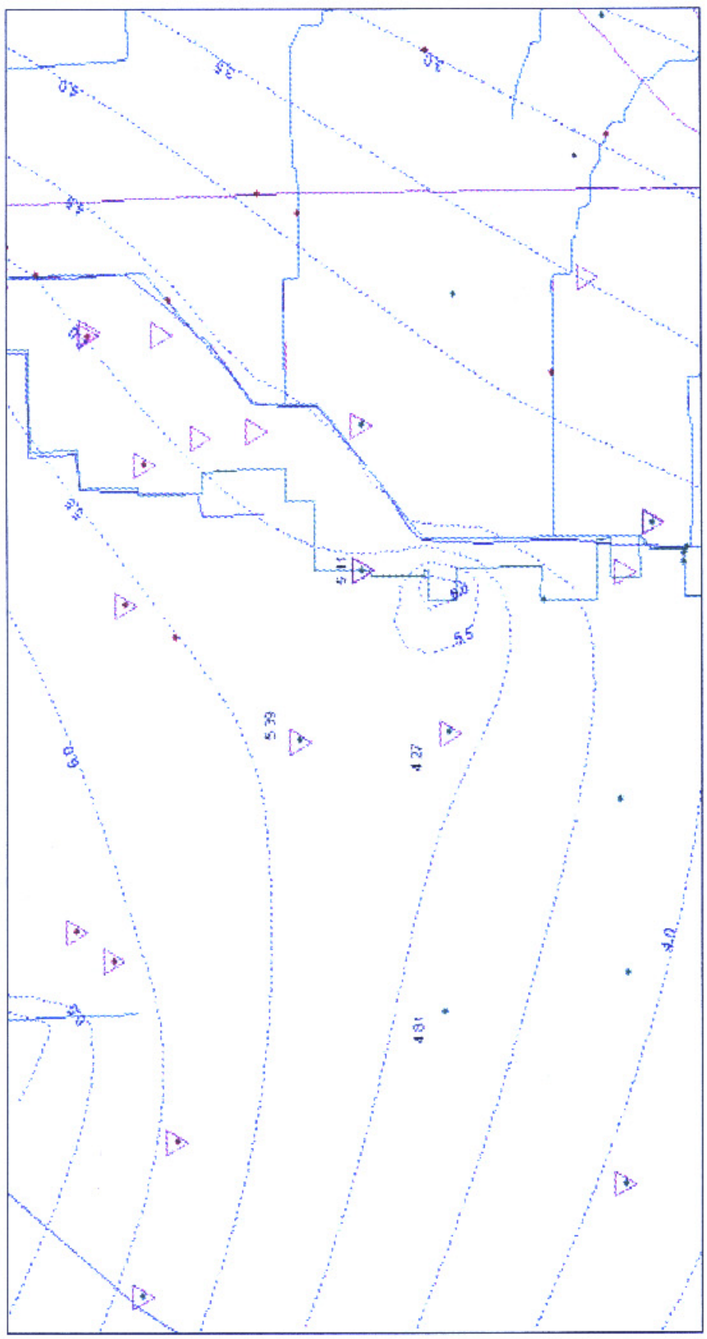


Figure 4.25. GFLOW modeled water level contours when S-332B is full.

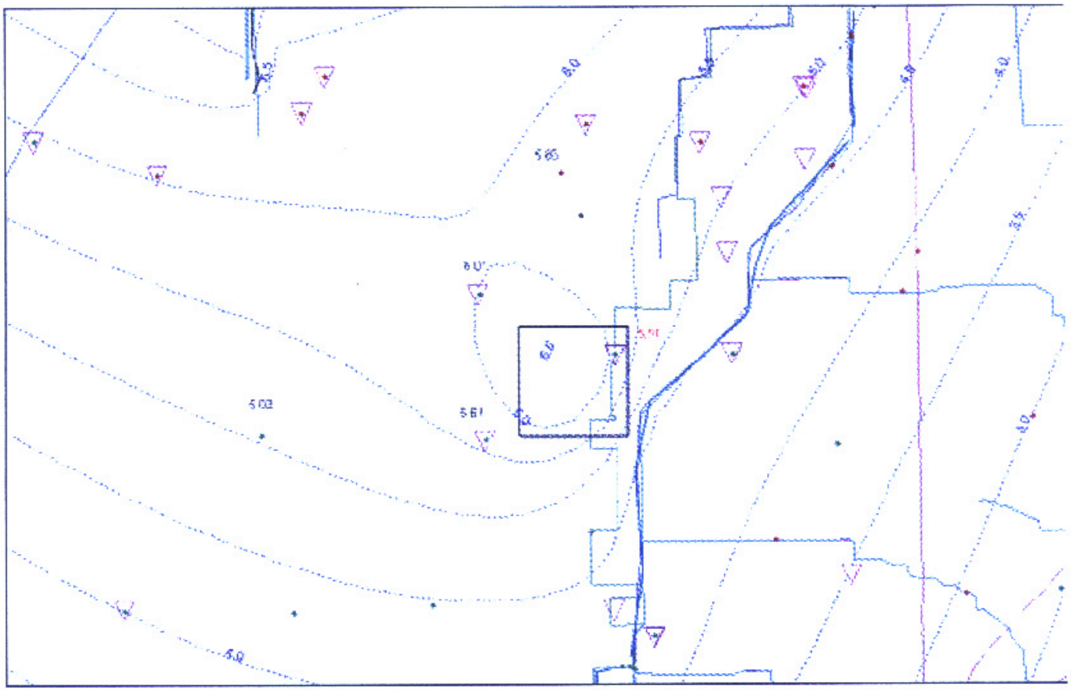


Figure 4.26. GFLOW water level contours with S-332B discharge is spread over 2x2 mile area (as in SFWMM).

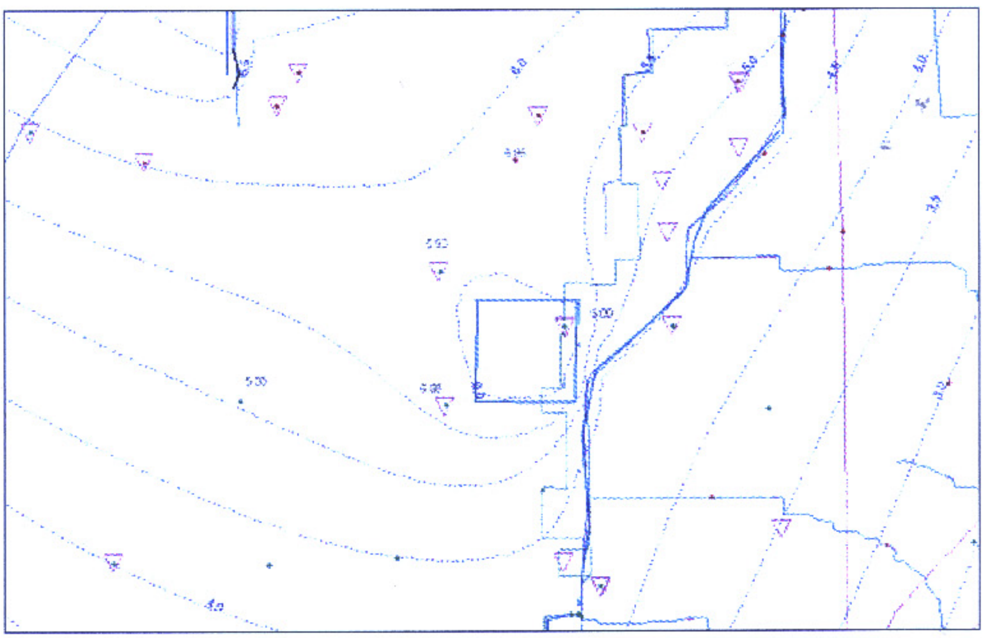


Figure 4.27. GFLOW water level contours with S-332B represented by average water level over 2x2 mile area (as in SFWMM).

tion area. This revelation accentuates the need for documentation, verification and calibration of new modeling code used for NEPA analysis.

Other discrepancies that indicate that the SFWMM simulations do not adequately represent the ISOP operations include:

1. Headwater constraints at S-335 are implemented in the SFWMM to maintain a maximum headwater of 7.5 feet. **(Figure 4.28)**. In reality, the S-335 structure is being operated to maintain a 6.0 feet. headwater **(Figure 4.29)**. The result of these model discrepancies would be a failure of the SFWMM to simulate drainage of the Pennsuco wetlands and WCA-3B. In addition, much less water would be moving through L-31N and C-111 in the model simulation than in reality. Potential flooding of eastern CSSS habitats would not be simulated in the model.

2. In SFWMM runs using v 3.81, lowered water levels at G-211 caused drainage impacts in NESS **(Figure 4.30)**. This was a result of correcting an error in v 3.8, in which water supply flows were not considered in computing the leakage from NESS to L-31N (Santee, Personal Communication). When the error was corrected in v3.81, the ISOP operations showed an impact in NESS. Subsequent checks on the calibration indicated that further calibration of the model was needed to accommodate these changes in the modeling code. To date these calibration changes have not been completed. This revelation casts uncertainty on the v3.8 model and the reliability of the leakages from NESS to L-31N. Because the model gave the right heads using the wrong flows, there is some error in the leakage simulation. We suspect that leakage from NESS to L-31N would be greater than the leakage modeled in v 3.8 but less than the leakage modeled in v 3.81.

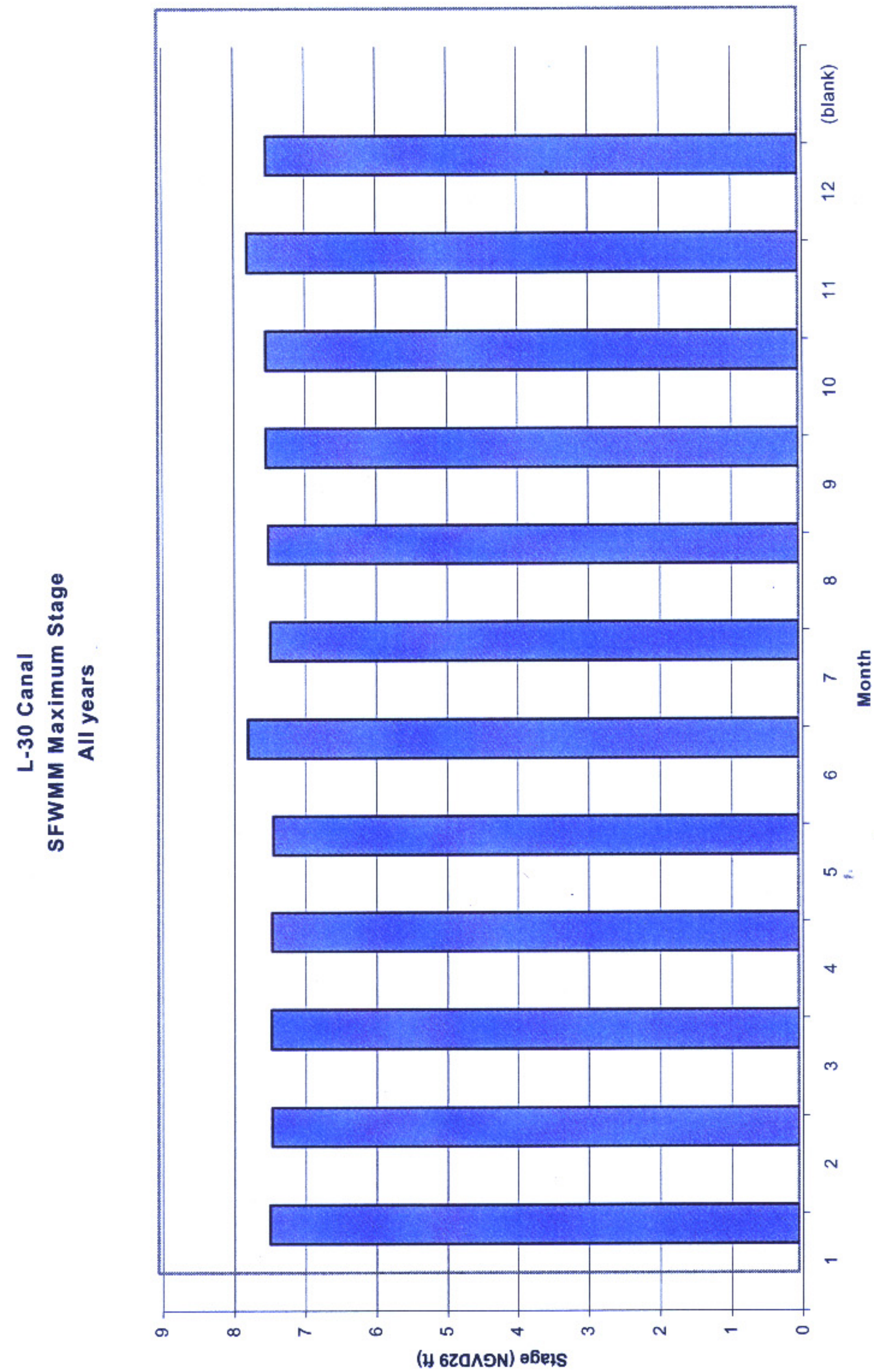


Figure 4.28. Maximum stage in L-30 canal reflects 7.5 feet headwater constraint at S-335.

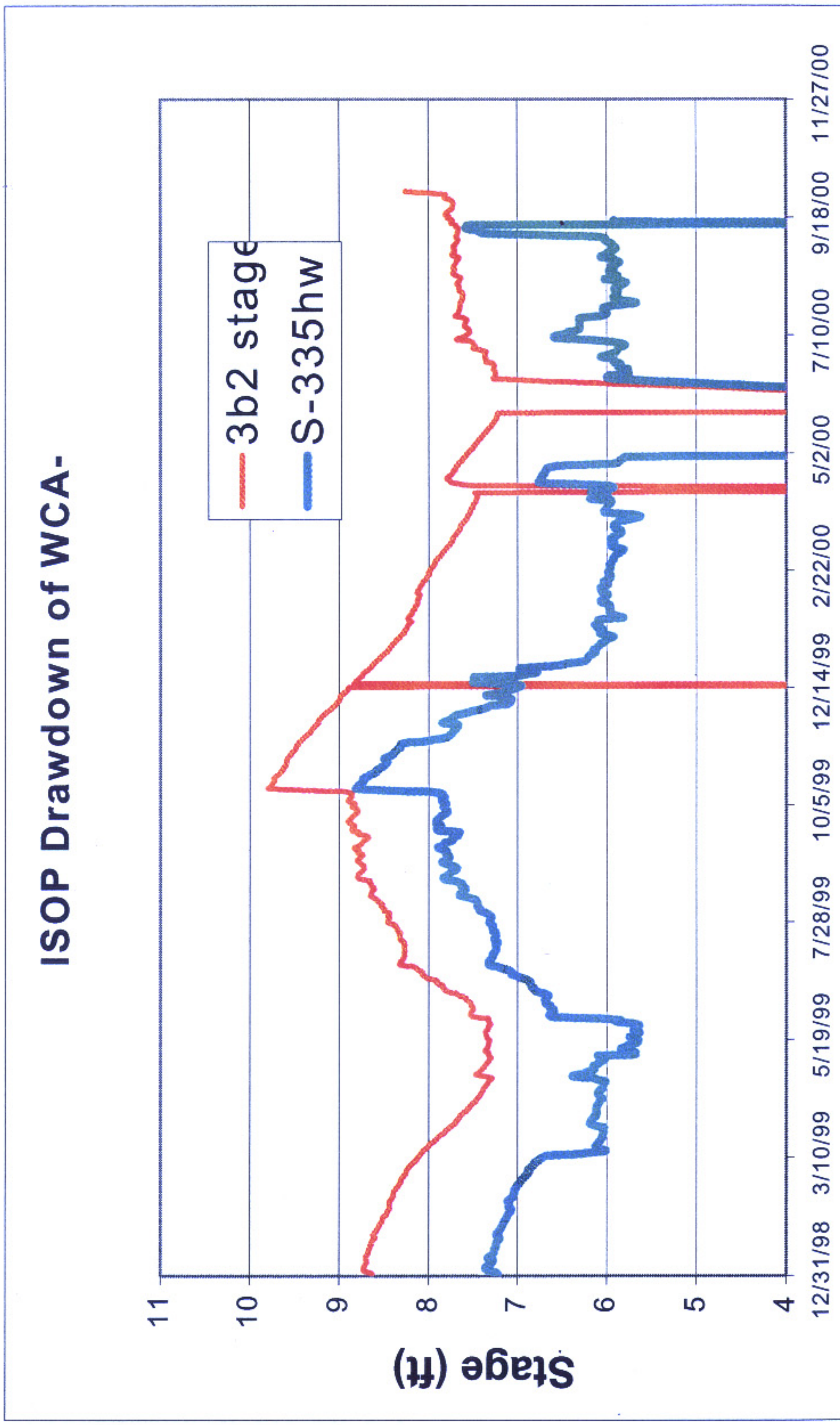


Figure 4.29. Reduction in S-335 headwater causes water level declines and loss of storage in WCA-3B (3b2).

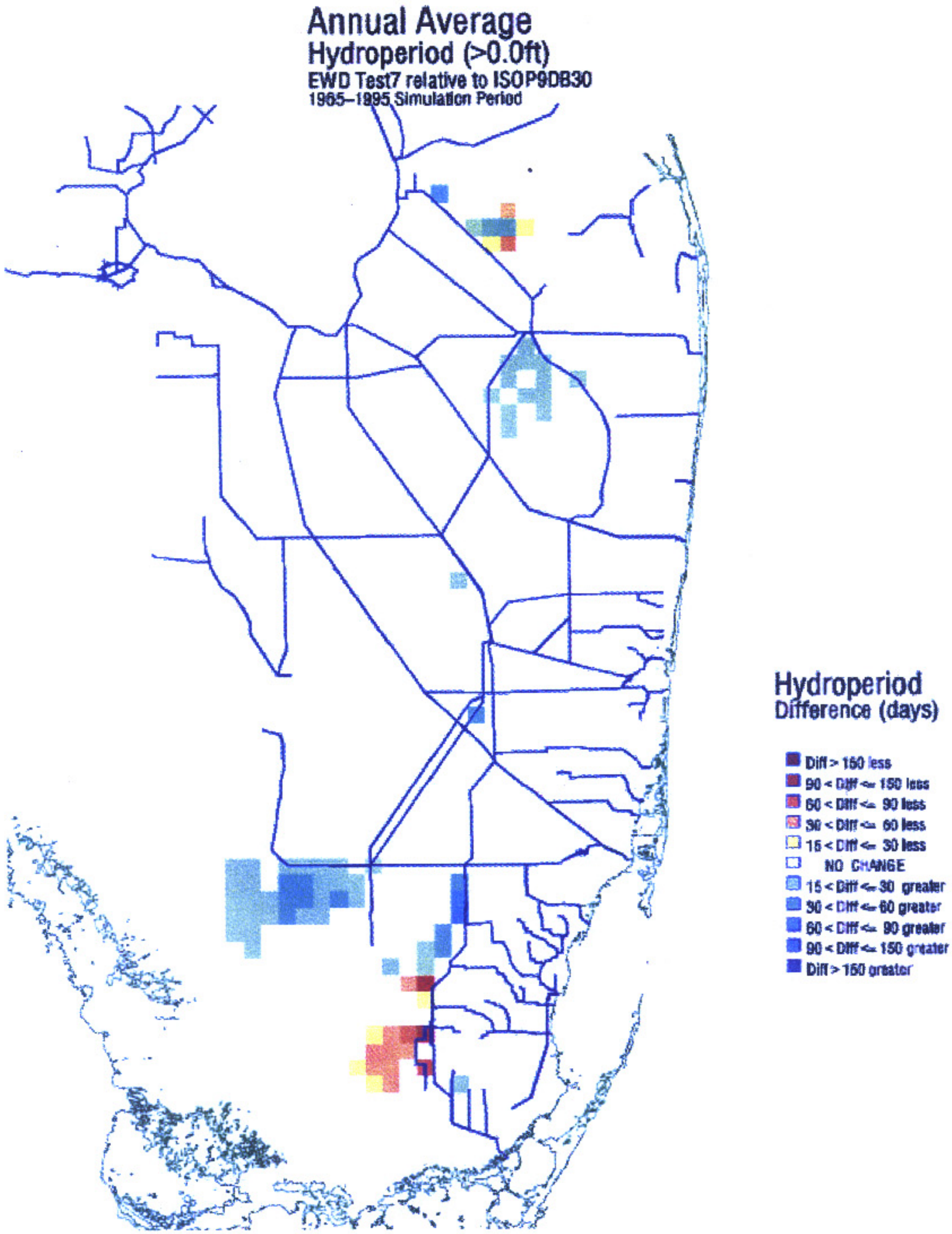


Figure 4.30. SFWMM v3.81 ISOP9DB30 model indicating decrease in hydroperiod in NESS.

4.5 ISOP Implementation (1999-2000)

In examining the applicability of the modeling, one verification procedure is to analyze the effects of modeled operations when actually implemented. This section reviews the actual ISOP operations to arrive at observations about the performance of the models.

4.5.1 Local and Regional Rainfall and Climate

In order to understand the effects of the ISOP operations in 2000, it is necessary to characterize the rainfall and other climatic influences in relation to previous years. **Figure 4.31** depicts the total monthly rainfall from the early dry season through the late wet season. The locations of the stations used in **Figure 4.31** are shown in **Figure 4.32**. Rainfall in the Rocky Glades was notably heavier than the other stations throughout most of the wet season. The heavy rains associated with Hurricane Irene created extremely wet antecedent conditions to the 2000 dry season. However, in terms of total annual rainfall, the analysis detailed below would characterize 2000 as an average to "1-in-3" dry year.

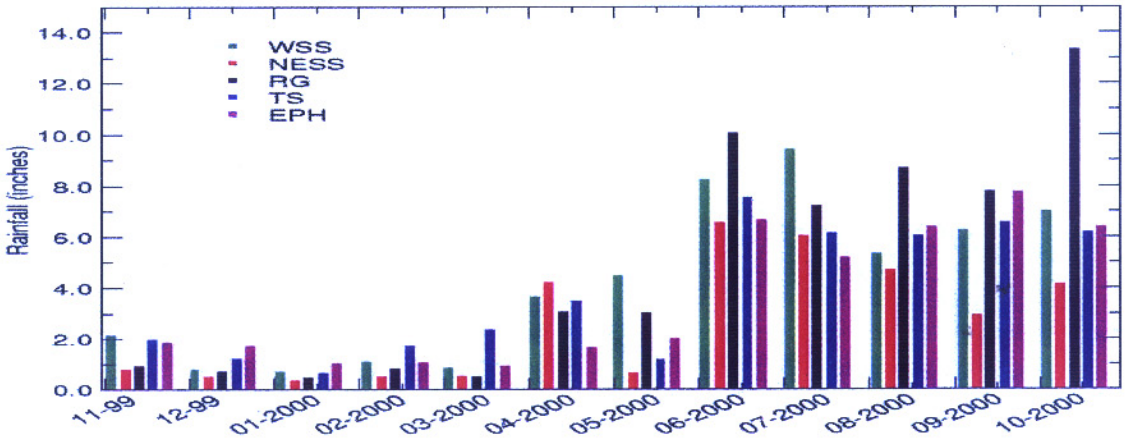


Figure 4.31. Total monthly rainfall at monitoring stations for regions within ENP.

Several approaches were taken to characterize the return period of the 2000 rainfall and associated climatic effects on moisture availability. Rainfall return periods were calculated from monitoring stations inside of ENP. Precursory investigations indicated that two stations, Royal Palm (RPL) and Forty Mile Bend (FMB), would provide the most complete record with the least amount of missing data. Furthermore, in order to correlate rainfall return periods to hydroperiods, the years included in calculating the local rainfall return period needed to be the same as the years used to calculate hydroperiod return periods. A time period was chosen for this analysis that would provide for the most complete data set for the combined hydroperiod and rainfall

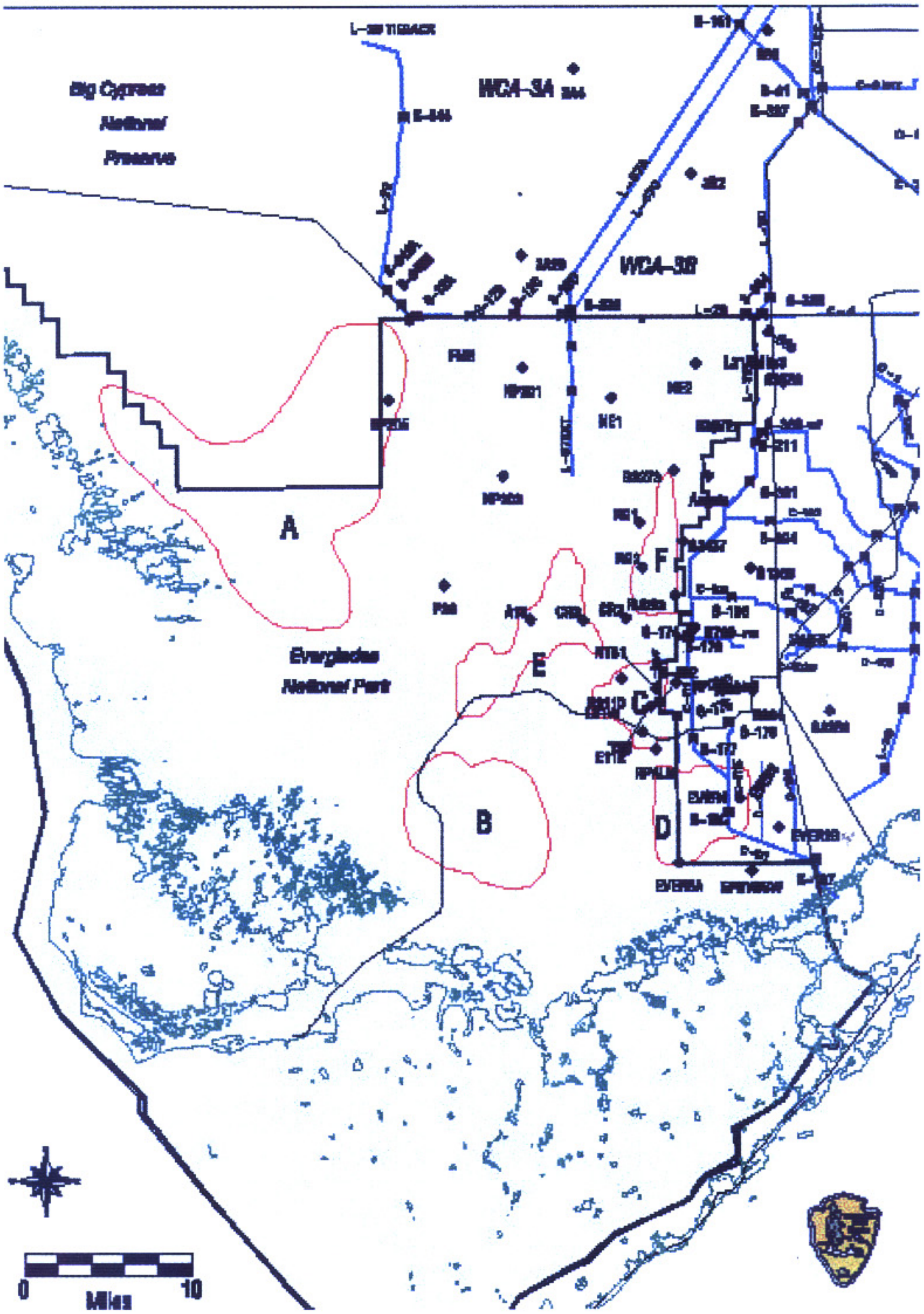


Figure 4.32. Cape Sable seaside sparrow sub-populations and monitoring stations.

analysis. The results are represented in **Figure 4.33 and Figure 4.34**. At both FMB and RPL the 2000 year rainfall roughly corresponds to a “1-in-3” year drought.

An additional analysis of data from the National Climatic Data Center provided a more long term regional estimate of the return periods for the EVERSW and the Lower East Coast (LEC) regions **(Figure 4.35 and Figure 4.36)**. According to the EVERSW plot, which includes all of Southern Florida south of Lake Okeechobee, 2000 annual rainfall was roughly a “1-in-10” year drought. According to the LEC analysis, which includes only the area of south Florida east of the Everglades in Miami-Dade, Broward and Palm Beach counties; 2000 annual rainfall would be characterized as average to a "1-in-3" year drought. The LEC results agree more closely with the ENP results, suggesting that the drought was more severe in the central part of the state.

In order to estimate how much error is involved in using the period between 1986-2000 for the ENP estimates, the EVERSW return period was re-calculated using only the years between 1986 and 2000 **(Figure 4.36)**. This analysis indicated that the return period for 2000 rainfall was about 8 years, compared to a 9 year return period for the full 100 year period of record, suggest-

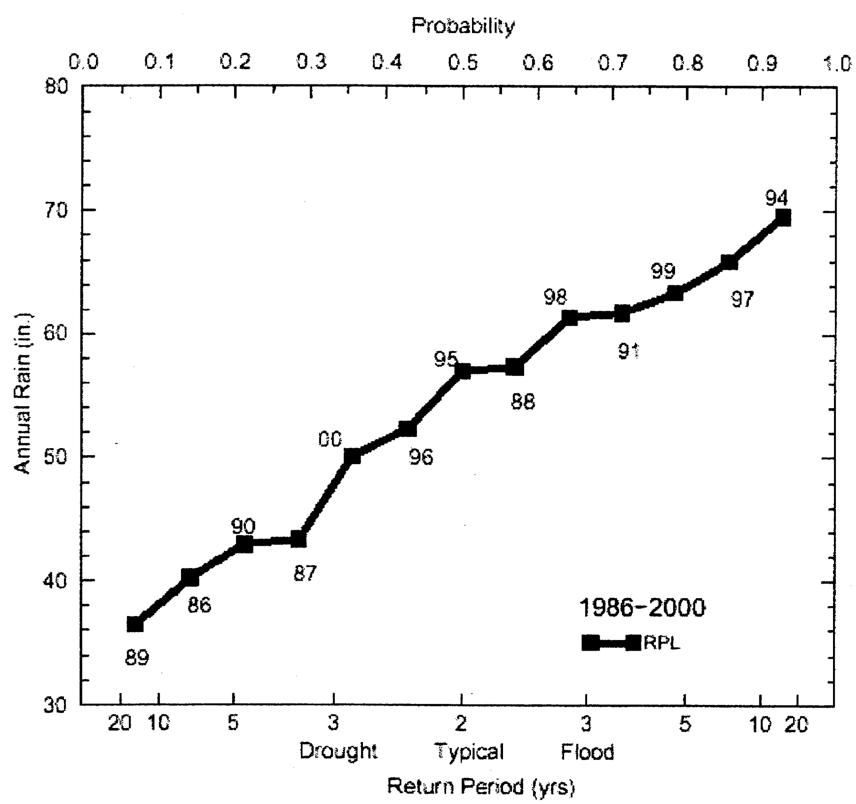


Figure 4.33. Royal Palm annual rainfall probability distribution (1986-2000).

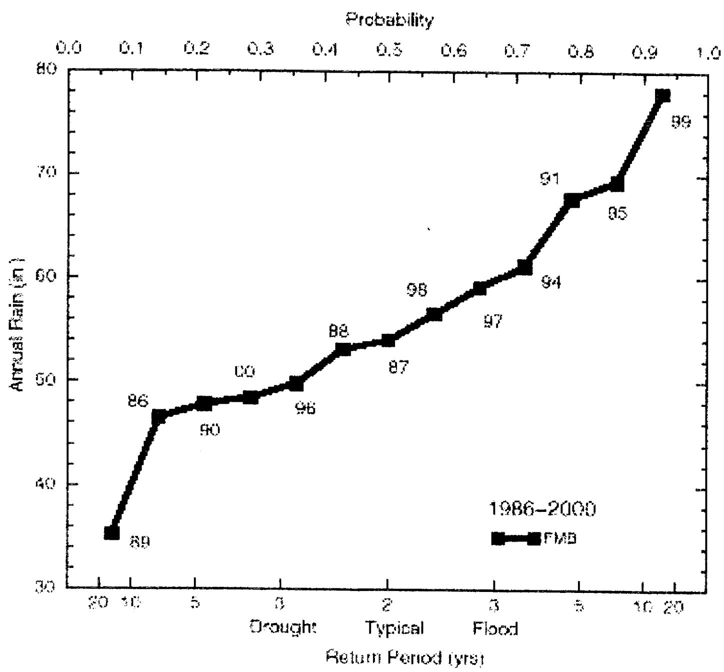


Figure 4.34. Annual rainfall probability distribution for NCDC station 1986-2000.

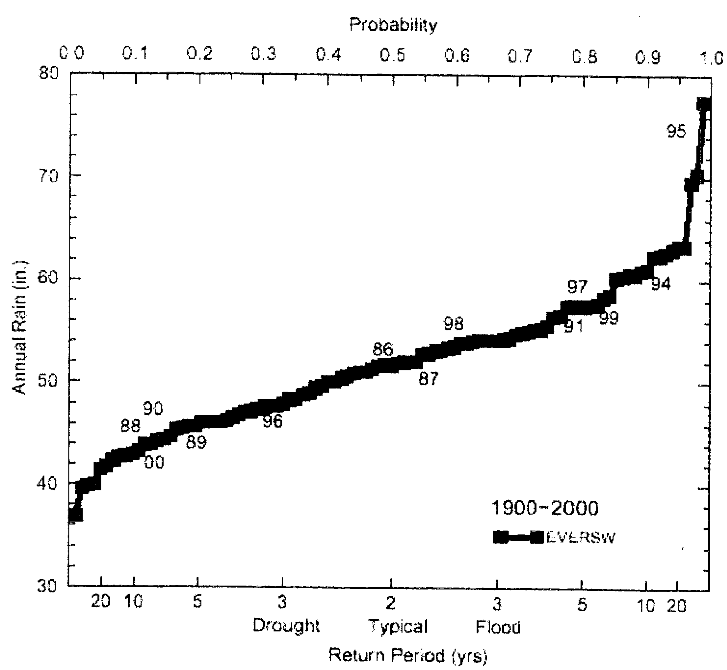


Figure 4.35. Annual rainfall probability distribution for NCDC EVERSW region (1900-2000).

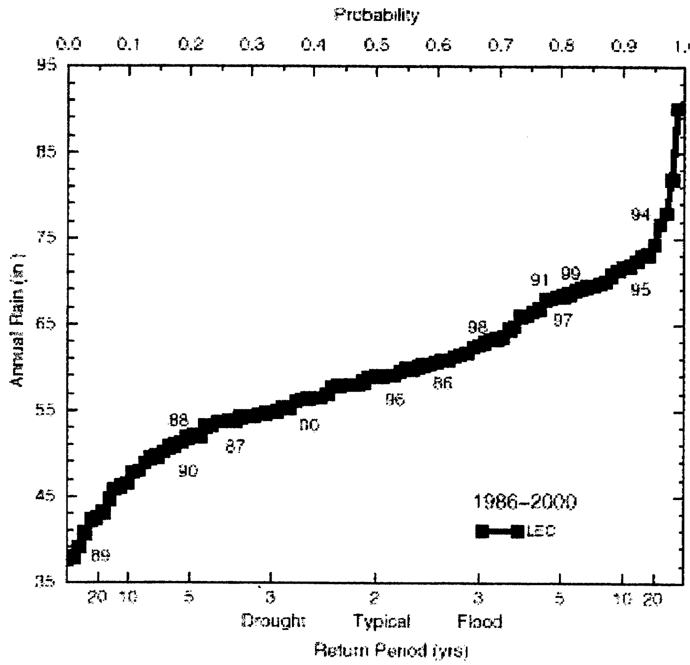


Figure 4.36. Annual rainfall probability distribution for NCDC LEC station (1900-2000).

ing that the interval 1986-2000 contains sufficient variability in rainfall to determine return periods with a reasonable degree of confidence. Therefore we characterize the 2000 rainfall return period locally to be consistent with a "1-in-2" or "1-in-3" year drought, while the 2000 regional rainfall return period would be consistent with a "1-in-8" or "1-in-9" year drought.

The Palmer Drought Severity Index (Karl et al. 1986) for Southern Florida **(Figure 4.37)** characterizes the "moisture demand" excluding the influence of human manipulations. The Palmer Index indicates that moisture demand increased throughout 2000 following a moderately moist 1999 wet season. According to the Palmer Drought Severity Index, early 2000 can be characterized as normal, whereas late 2000 would be characterized as mild to moderate drought. The Palmer Hydrological Drought Index is formulated to indicate long term moisture demands. According to the Palmer Hydrological Drought Index **(Figure 4.37)**, January 2000 was moderately wet, while the December index indicates mild to moderate drought. Under all drought measures, April 2000 is wetter than normal. However, in terms of local April rainfall, the determination is less clear, particularly for the April 13 event, which disrupted CSSS nesting.

In the After Action Report (USACOE 2000) The Corps used a NEXRAD, or radar, image to show where the April 13 rainfall occurred. Rainfall amounts exceed, according to this data, 24 inches in WCA-3B, and show amounts exceeding 10 inches over much of the Western CSSS habitat. They then estimate 8.65 inches of rainfall over the "NP-205 basin", which is approximately a "1-in-500" year event.

Table 4.8 is a comparison of observed rainfall and the COE estimate based on NEXRAD. If we

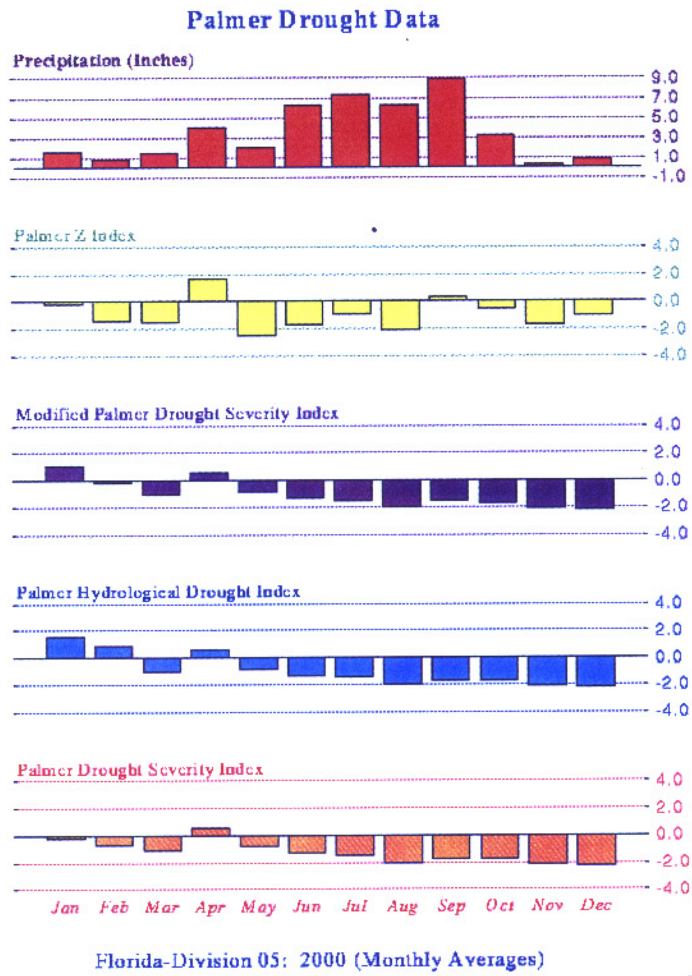


Figure 4.37. NCDC drought indices for south Florida (Region 5).

Table 4.8. Comparison of observed rainfall and the COE estimate based on NEXRAD.

Location	Observed	COE Estimate
40 Mile Bend	6.26”	6.2”
S12D	8.53”	15”
NP205	3.80”	8.75”
P34	3.95”	5.75”
NESS1	3.86”	15”
Peterson’s	3.95”	7.5”
P33	2.52”	4.5”
NP202	2.06”	7.5”
NP203	2.29”	6.0”
3A-28	9.25”	18.0”
3B-2	3.72”	7.0”

assume that the characteristics of FMB rainfall observed since 1949 are representative of the area, then **Figure 4.38** is our estimate of frequency contours for the event. The return periods are very high along Tamiami Trail, and drop as one moves south. Over much of the western CSSS habitat, rainfall for the month of April was below normal, while for the northern edge, it was about "1-in-10" year wet. At NP-205, the return frequency of the 3.80" was approximately "1-in-5" year wet.

4.5.2 Hydrologic Results of ISOP Operations

In addition to effecting CSSS habitat, the operations specified in the ISOP change the overall hydrology of ENP and the storage capacity in the WCAs. The remainder of this report will focus on characterizing general changes in ENP hydrology, changes in storage in the WCAs and hydrology of the CSSS sub-population habitats.

To investigate the implementation of the ISOP for the 2000 calendar year, it is necessary to consider two different sets of operations. Operations before the March 2000 EA included modifications to the pre-ISOP EWDT71 operations to improve hydrologic conditions for the CSSS sub-populations. Operations after March 2000, included new operations to "lower canal levels during the wet season and allow for higher water levels during the dry season." (USACE 2000). The following summary of the dry season operations was extracted from the ENP 1999-2000 Status and Trends Report (Knight et al. 2001) and the Corp's After Action Report.

The most critical operation of the early 2000 dry season was to allow for early closure of the S-12 structures in order to maximize nesting opportunities in CSSS sub-population A. The Corps diverted water from WCA-3A by closing the S-11 structures on November 12. In order to reduce flow to sub-population A they closed S-12A on December 16th. In **Figure 4.39** the increased recession rate due to closing S-12A is apparent. On December 18th S-343 and S-344 A&B were closed and the culverts in the L-67 extension were opened in order to direct flow towards CSSS sub-population E. On December 29th S-12B was closed and S-151 was opened to divert flow from WCA-3A to tide through S-31. These discharges down the Miami Canal continued for a period of 3 months. Flows not accommodated by S-31 entered WCA-3B to be subsequently removed by seepage to L-30 over approximately the same period of time. L-30 seepage was than subsequently conveyed to the SDCS and its' intended destination, S-332D.

On January 5th S-333 and S-334 were opened to divert additional water from WCA-3A. According to the Corps after action report "During periods when G-3273 was above 6.8 feet and WCA-3A was above regulatory schedule, water was passed through S-344 and into L-31N (more than 42,000 acre-feet). No flood impacts on private properties have been reported along L-31N since the ISOP has been in place." Despite these findings, the new wet season operations outlined by the Corps in the March 2000 EA, prescribed routing water from WCA-3A via S-151 and S-335, rather than through S-333.

On January 15th, WCA-3A dropped into Zone C. According to the ISOP regulation schedule

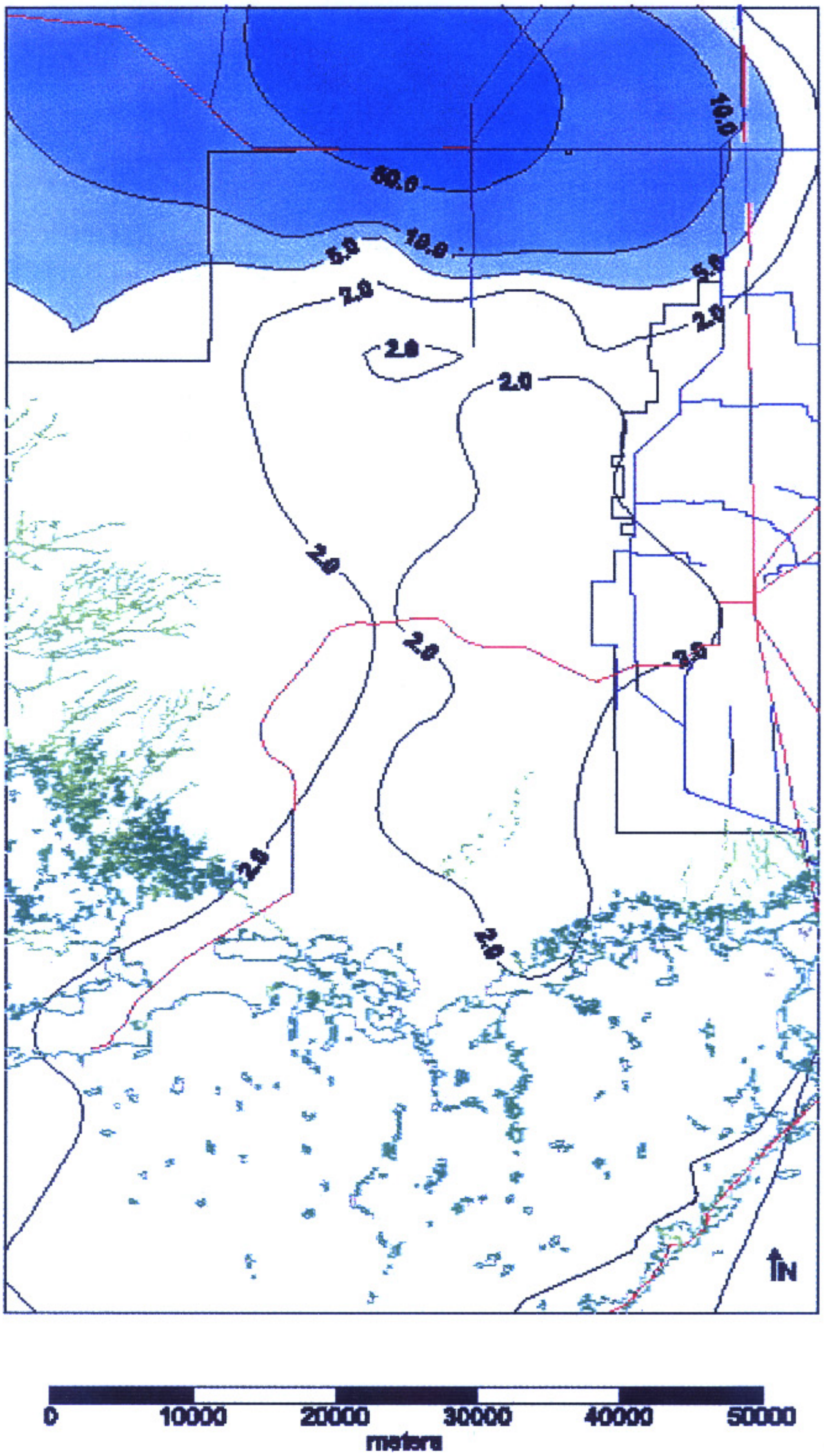


Figure 4.38. Rainfall frequency contours for April rainfall event.

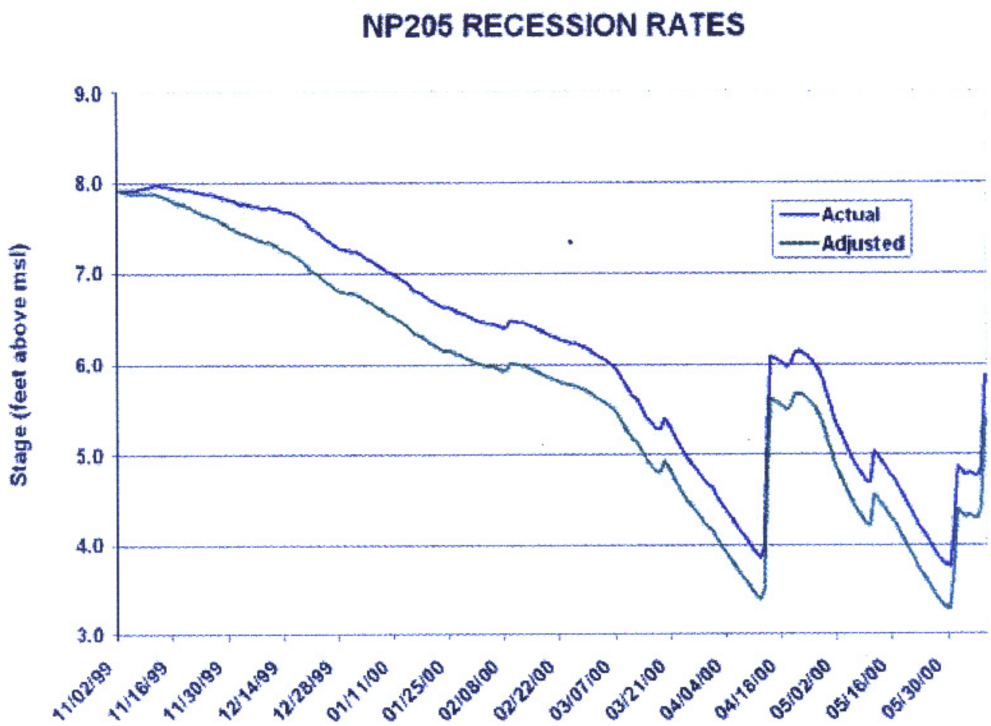


Figure 4.39. Actual and predicted NP205 stage recessions for the 2000 dry season.

(Table 4.9) all S-12 structures could be closed. Finally on February 15th, about 10 days after WCA-3a had receded into Zone E1, S-12C and D were closed. **Figure 4.40** shows the benefits of S-12 closures on the recession rate at NP-205 soon after their closure. On February 17 flows to the SDCS and S-332D were reduced. **Figure 4.40** shows the benefits of S-12 closures on the recession rate at NP-205.

4.5.2.1 Hydrologic Analysis of ISOP operations for the 2000 Dry Season

The analysis of the existing conditions begins with WCA-2A and continues downstream through the system. The focus is on the operations to try to identify impacts of the ISOP and gain a better understanding of the hydrologic system and how it may respond to similar operational approaches in the future. The analysis will consist of a summary of the observed flows for the dry season of 1999-2000, refer to **Figure 4.41** and **Table 4.10**, with stage and discharge hydrographs for the major basins from WCA-2 to ENP.

The hydrology in south Florida for this period was strongly influenced by an above average wet season followed by heavy rainfall from Hurricane Irene. Thus, the beginning of this period represents relatively high, but not unprecedented water levels. Conditions similar to these were experienced in October of 1995.

Table 4.9. ISOP WCA-3A regulation schedule.

Zone	Description	S-12's	S-333/S-355A&B	S-151
A	Flood Release	open full unless S-12 A and B must be closed	maximum allowable discharge if G3273 < 6.8 ft NGVD or capacity is available via S-334/SDCS.	Maximum allowable discharge when WCA 3B stage is below 8.5 ft, NGVD.
B	Upper Transition wet season	Discharge 45% of computed flow if S0333 is closed or discharging less than 28% of computed flow, S-12 must discharge at least 73% of computed flow	Discharge up to 55% of computed flow when permitted and for water supply to ENP-SDCS if G-3273 <= 6.8 ft.	Maximum allowable discharge when WCA 3B stage is below 8.5 ft, NGVD
C	Upper transition dry season	Close S-12's if discharge poses a threat to CSSS nesting	Same as zone B	maximum allowable discharge when WCA-3B is < 8.5 ft. NGVD.
D	Lower transition dry season	Same as zone C	Same as zone B	water supply
E	Rainfall formula only	no regulatory releases	no regulatory releases	water supply
E1	Sparrow nesting	minimize use of S-12's	maximum releases at S-142, S-151, S-31, S-337, S-335, S-333, s-355 A & B, S-334 when permitted by down-stream conditions	maximum releases at S-142, S-151, S-31, S-337, S-335, S-333, s-355 A & B, S-334 when permitted by down-stream conditions

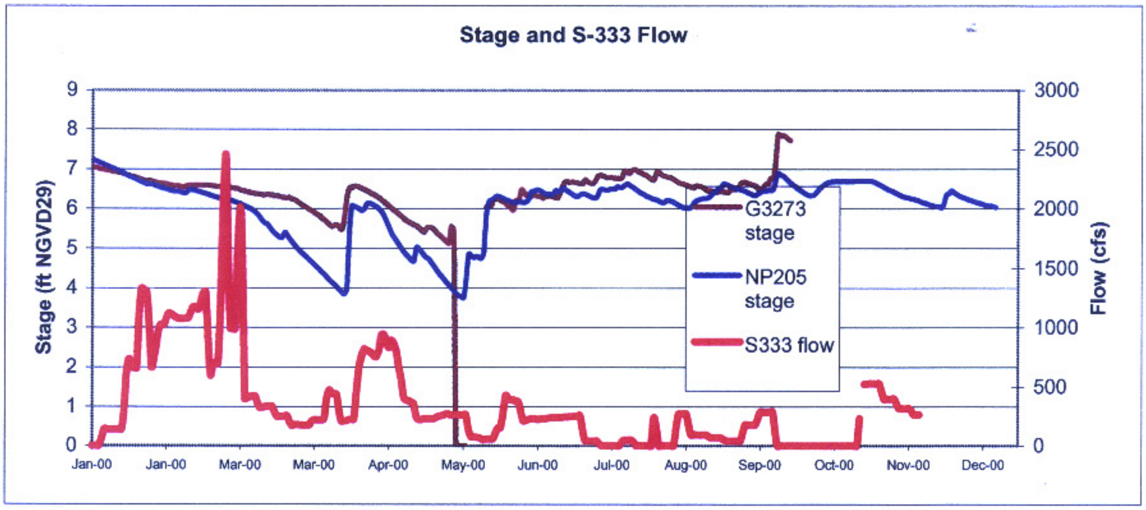


Figure 4.40. S-333 flow and stage at G-3273 and NP-205.

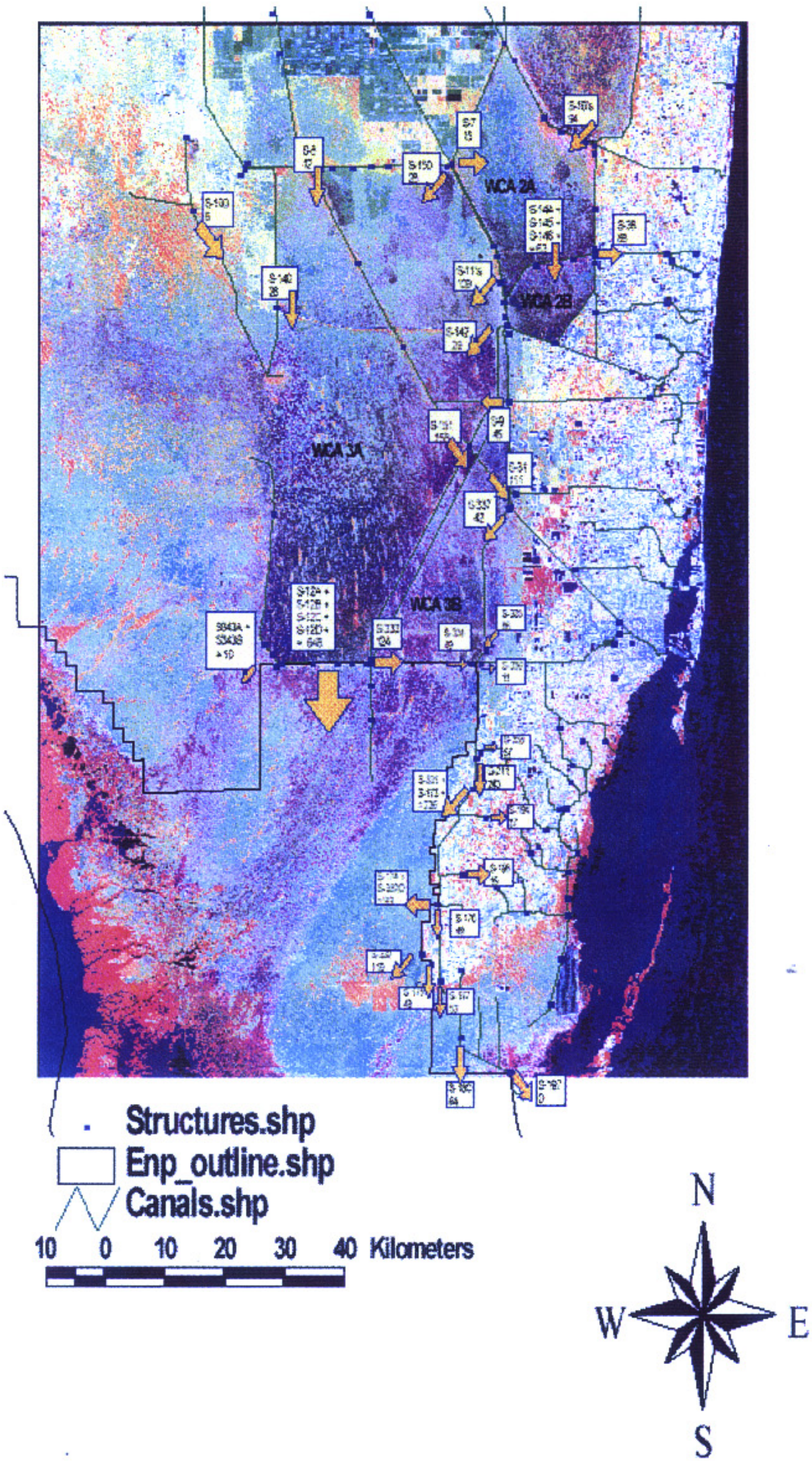


Figure 4.41. Canal water budget analysis for the 2000 dry season Nov 1, 1999– May, 31, 2000. Flow values are in K-acre-feet.

Table 4.10. ISOP Water budget

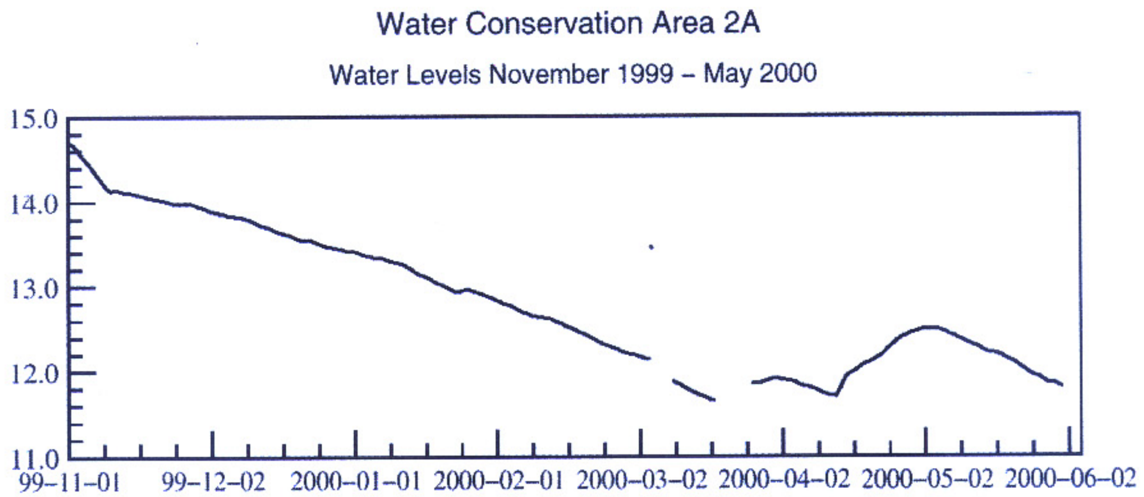
	Inflows k-acre-ft	Outflows k-acre-ft	Net k-acre-ft
WCA-2A	109	260	-151
WCA-2B	63	29	34
WCA-3A	255	949	-694
WCA-3B	151	153	-2
L-29	124	49	75
L-31N Upper Reach	135	311	-176
L-31N Mid Reach	243	236	7
L-31N Lower Reach	236	200	36
L-31W	99	167	-68
C-111 Upper Reach	49	53	-4
C-111 Middle Reach	53	64	-11
C-111 Lower Reach	64	0	64

4.5.2.1.1 WCA-2

WCA-2 discharged over twice as much water as it received. This is largely due to the high water levels in the basin at the beginning of this time period caused by Hurricane Irene and the 1999 wet season. The largest portion (42%) of the outflow was directed to WCA-3A through the S-11 structures; S-38 discharged 34% of the total outflow to the LEC; The rest, approximately 63,000 acre-feet was directed into WCA-2B where approximately half was then released into WCA-3A. **Figure 4.42** depicts the water level in WCA-2 from gage 2A-17. This figure clearly shows the effect of the S-11 structures as the sharp decrease in recession during the second week of November. This is due to closing the S-11s as per the ISOP, which altered the regulation schedule of WCA-2A. This was done in an effort to allow WCA-3A to recede while restricting outflow through the S-12 structures in an attempt to protect CSSS sub-population A. Without the S-11 outlet, it took approximately 5 months for the stage in WCA-2A to recede by 2.5 feet.

4.5.2.1.2 WCA-3 and Northwest Shark Slough

WCA-3A discharged more than three times the water received. This is also a response from Hurricane Irene and the 1999 wet season. At the beginning of this period the "three gage average" (3A-3, 3A-4 and 3A-28) exceeded 12.5 feet. **Figure 4.42** shows the hydrograph for each of the 3 gages. Again the effect of the S-11s are clearly evident by the change in recession in 3A-3, the closest gage to the S-11s. By the end of this period the water level in WCA-3A had receded to below 9.5 feet. The bulk of the outflow, 650,000 acre-feet was directed into NWSS through the S-12 structures. This is even more significant when one considers that S-12A and S-12B were closed on December 16, 1999 and December 29, 1999 respectively. S-12C and S-12D remained fully opened until mid-February. In WCA-3B, outflows approximately equaled inflows



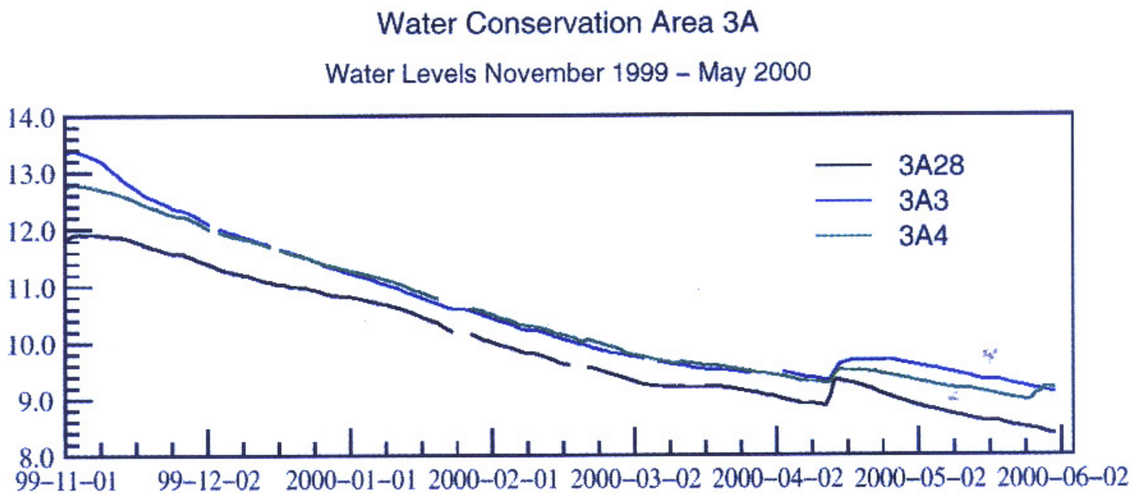


Figure 4.42. Water levels in Water Conservation Areas 2A (upper) and 3A (lower) November 1999– May 2000.

during this time period. The Experimental Water Deliveries Program was cancelled by the Corps and SFWMD following Hurricane Irene. According to the ISOP final draft dated December 8, 1999, S-333 would still be used if G-3273 was above 6.8 feet. In this situation, S-333 discharge would be routed through to the SDCS. Review of observed data, **Figure 4.43** indicates that this practice began during the first week in January 2000 when the water level at G-3273 was just under 7.0 feet.

Discharge through the S-12 structures is directed into NWSS and consequently toward CSSS

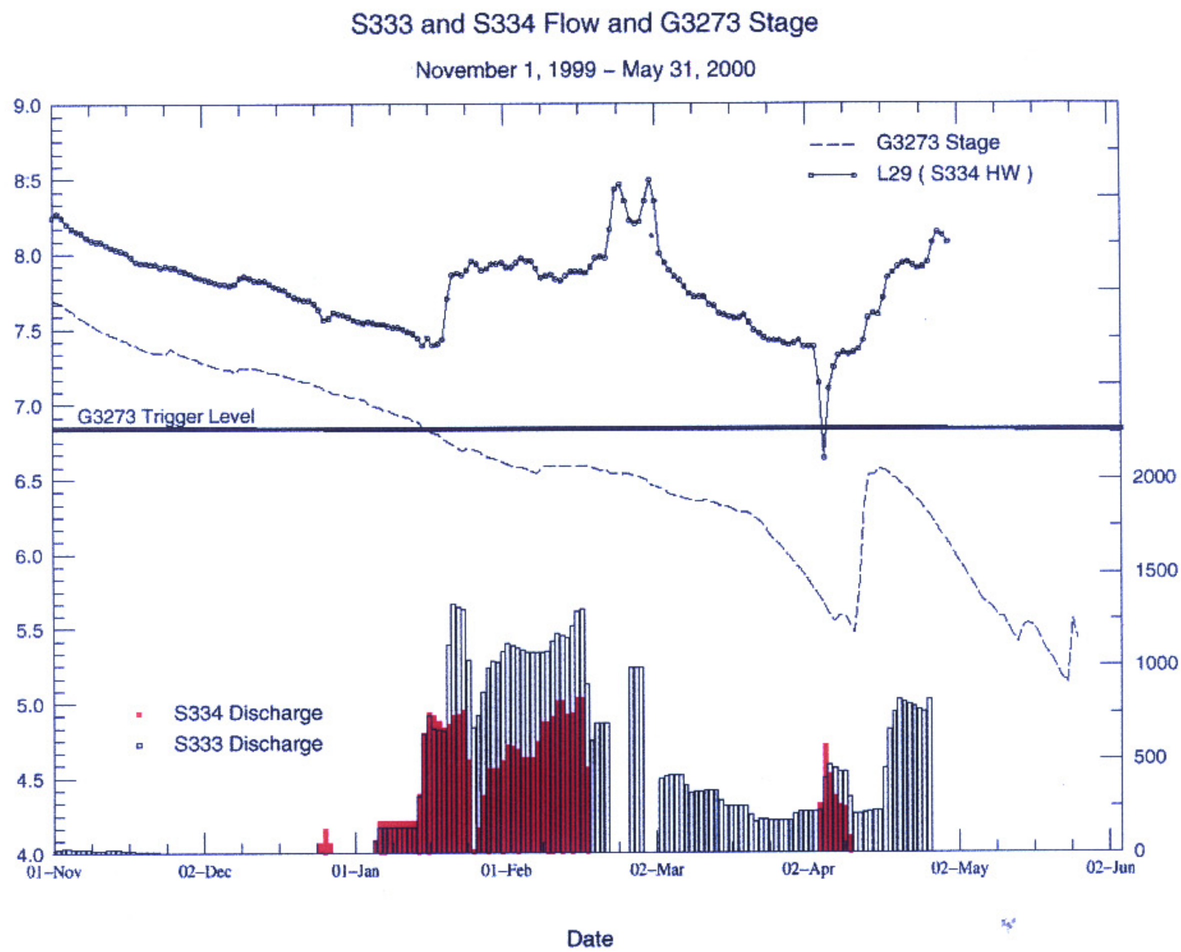


Figure 4.43. S-333 and S-334 Flow and G-3273 Stage Nov. 1, 1999– May 31, 2000.

sub-population A, which is located on the western edge of NWSS. **Figure 4.44** displays the water level and rain at gages located in sub-population A (**refer to Figure 4.45** for gage locations). All three gages in the figure show a similar response. The closing of S-12A and S-12B in mid-December seemed to accelerate the recession at these gages. However, the closing of S-12C and S-12D in mid-February is not discernable. **Figure 4.46** compares this year's recession with those from a variety of previous years. The additional years chosen include 1988 and 1989, which were relatively dry and 1995-1996 when water levels were similar to this year. The recession rates in the plot are normalized by setting each stage value equal to the stage on November 1, 1999. This allows for a more direct visual comparison of the recession rates. The figure shows that the recession at NP-205 for this year was more similar to the dry years than it was to a similarly wet year. The increase in recession rate over that of 1995-1996 is a direct result of closing the S-12 structures. During 1995-1996 the S-12 structures remained open throughout the dry season.

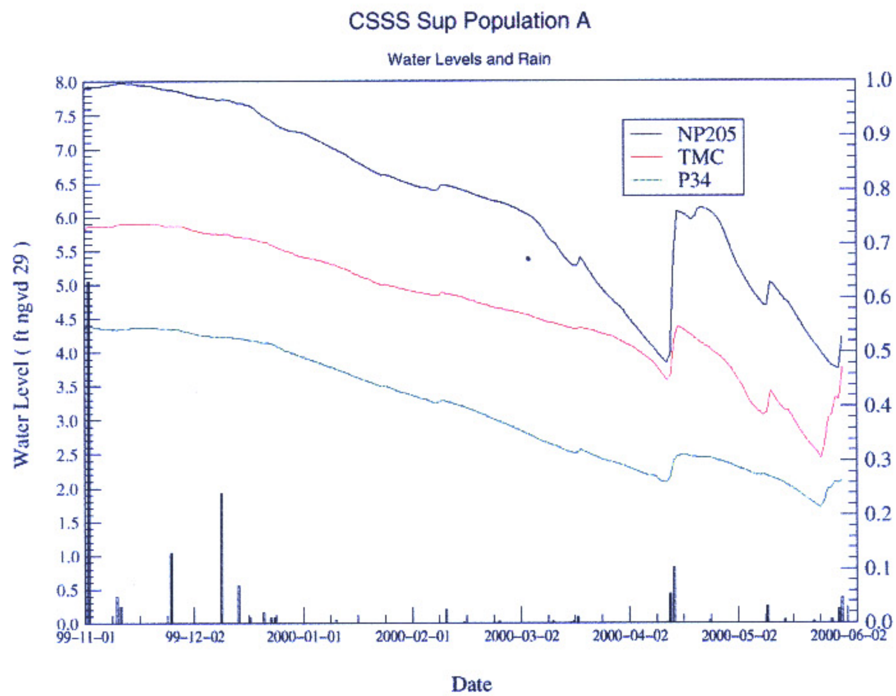


Figure 4.44. Water levels and rain within Cape Sable seaside sparrow sub-population A habitat, Nov. 1, 1999– June 2, 2000.

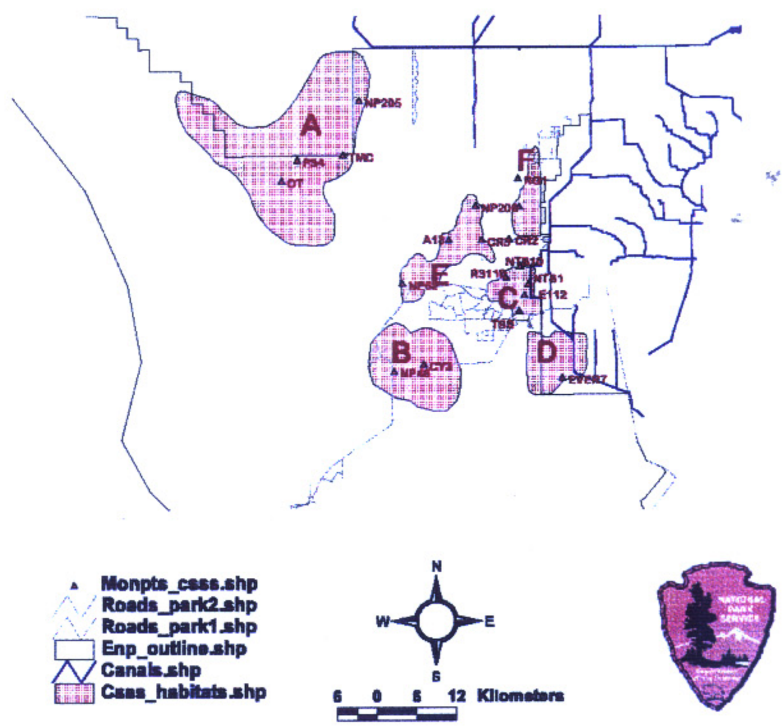


Figure 4.45. Water level and rain gages located in sub-population A .

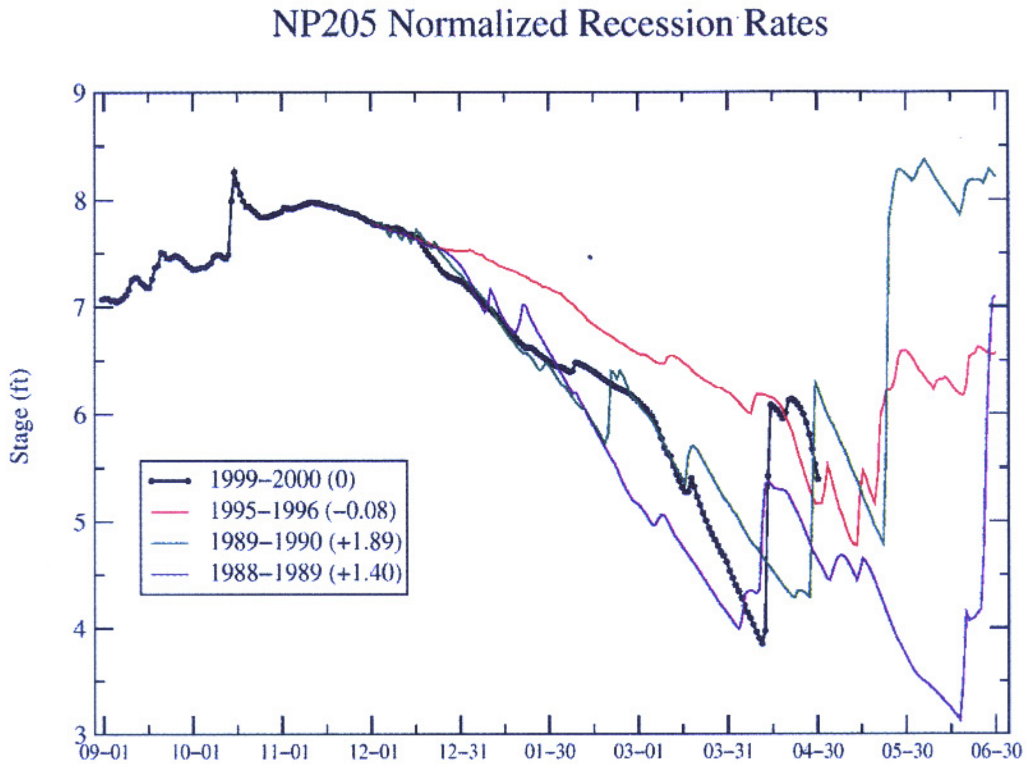


Figure 4.46. Station NP205 normalized recession rates.

4.5.2.1.3 L-29, Northeast Shark Slough and Upper L-31N

Inflows into the L-29 canal from S-333 exceeded outflows by 75,000 acre-feet. This flow entered NESS through the culverts under US 41 (Tamiami Trail). However, outflow in the upper reach of L-31N (from L-29 to G-211) exceeded inflows by 176,000 acre-feet. Thus, more water was drained from NESS than was introduced. This is an inevitable byproduct of routing flows from WCA-3 through the SDCS. With G-211 fully opened, water from NESS is drained into the canal. **Figure 4.47** illustrates the hydrology of this reach; NE-2 is consistently two feet higher than the canal. So while the goal of the operation is to route the same volume through the system, the canal stages required tend to accumulate flow via seepage from the marsh.

Figure 4.48 further illustrates the hydrology of this reach. This figure displays the net flow for this reach. Negative flows indicate the reach is being drained. Outflows from the reach were highest at the beginning of the period. This period correspond to the steeper recession rate at NE-2. In mid-January, net outflows decreased and the recession was practically halted. The next break in the recession curve corresponds to the drop in the G-211 headwater. Also evident in these plots is that even though the reach is being drained at various rates for the entire period, the headwater at G-211 is fairly steady. This is further indication of the drainage from NESS.

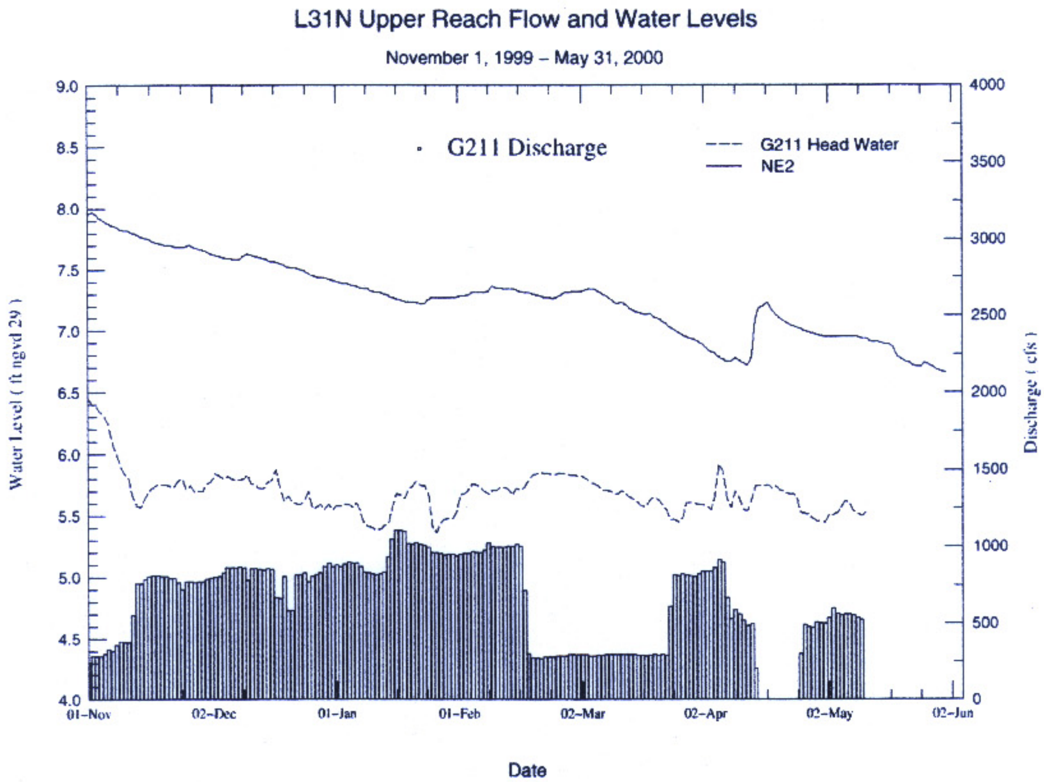


Figure 4.47. L-31N upper-reach of Flow and water levels, Nov. 1, 1999-May 31, 2000.

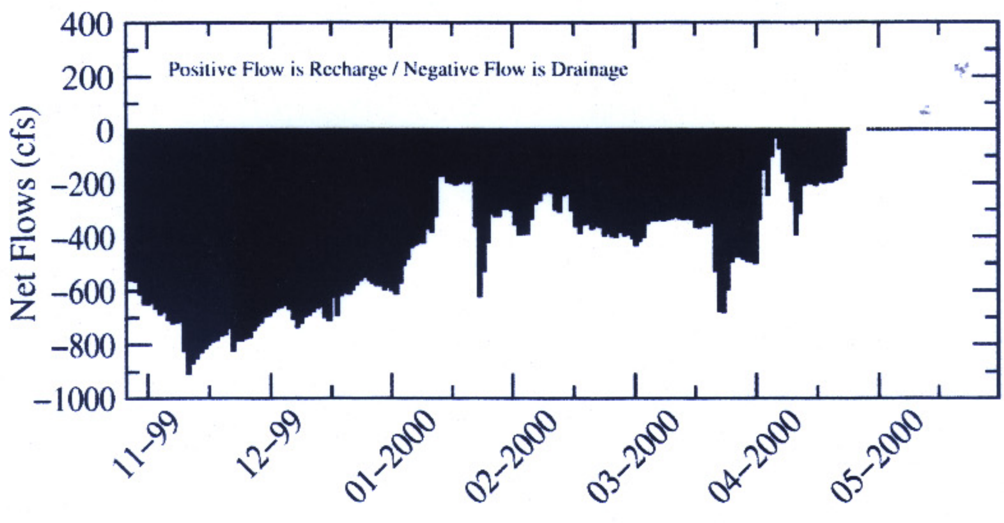


Figure 4.48. Upper net flows L-31N, Nov 1, 1999-May 31, 2000.

4.5.2.1.4 Middle L-31N

Flows in this reach from G-211 to S-331 were approximately balanced with net accumulation of 7,000 acre-feet. Operations in this reach are dictated by the Angels well criteria. **Figure 4.49** shows the water level at Angels well and S-331 headwater along with inflows and outflows. The water level at Angels well did not recede to below 5.5 feet until mid March, only to rise again a month later in response to above average April rain.

Figure 4.50 plots the net flow for this reach. Inflows balanced outflows for most of the period. The exception was late March when the stage at Angels well fell below 5.5 feet. Water mangers were then allowed to stop operations at S-331. However they continued to operate G-211.

4.5.2.1.5 Lower L-31

Water levels in this reach of L-31N, S-331 southward to S-176 is the most contentious operational criteria of the SDCS. Operations under the ISOP lower stages in this canal by over 0.5 feet over those agreed to in the Experimental Water Deliveries Plan.

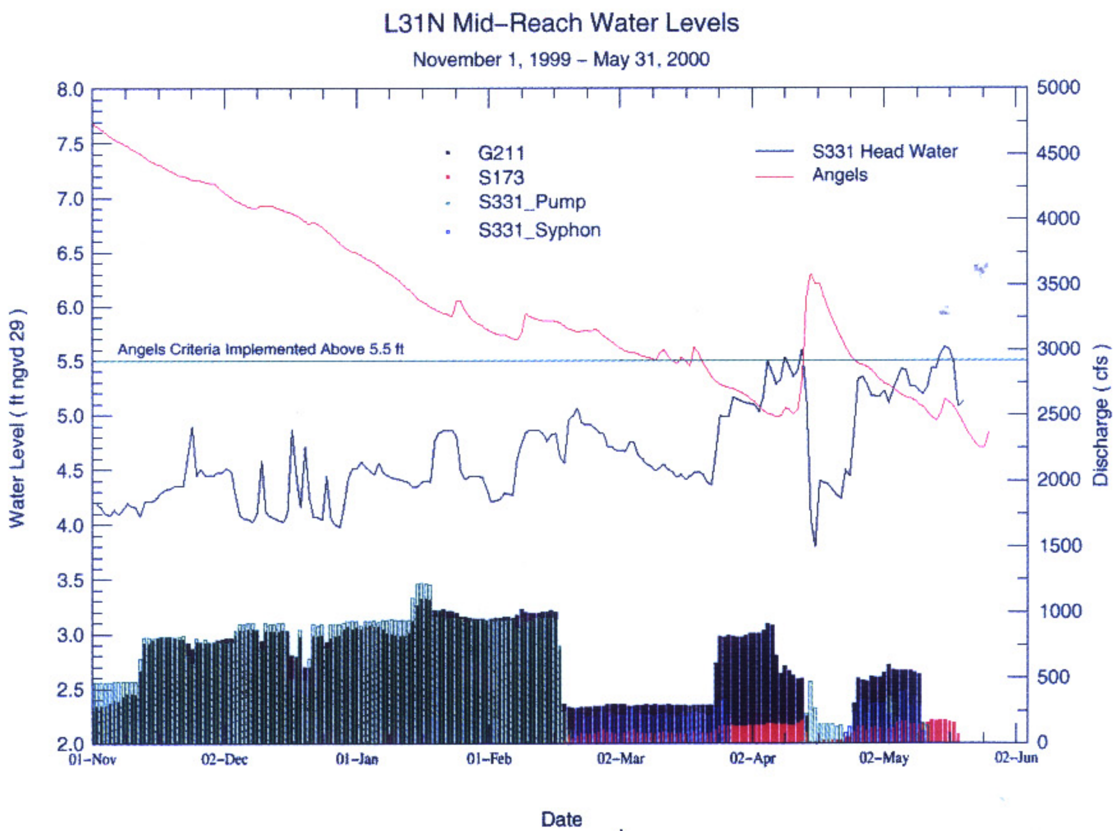


Figure 4.49. L-31N mid-reach water levels, Nov. 1, 1999-May 31,2000.

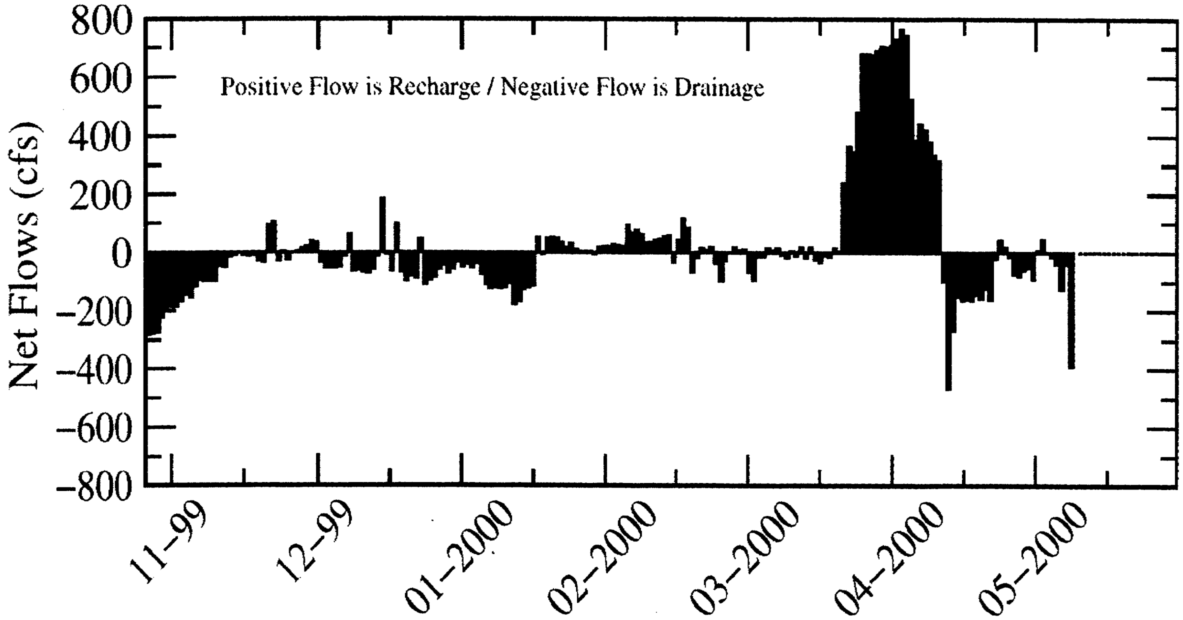


Figure 4.50. L-31N mid net flows, Nov. 1, 1999- May 31, 2000.

ENP has previously documented the adverse impacts of these lower canal stages (Johnson and Van Lent et al. 1993). This will inevitably cause increases in seepage losses from ENP and reduce hydroperiods. **Figure 4.51** shows an west–east view of the water surface profile through the Rocky Glades on two different days, December 30, 1999 when the canal was held at 4.91 feet and on January 16, 2000 when the canal was held at 4 feet 11 inches. The effects are clear. The head gradient towards the canal, and thus seepage out of ENP, has increased by 43 percent. The increase in flow out of the park for the entire ten-mile reach of the canal results when lower water levels are held in the canal.

Figure 4.52 shows the water level at RG-2 and S-176 discharge and headwater. The figure clearly shows RG-2 responding to the lower canal stage in L-31N with an increase in the recession rate. It is interesting to note that the net flow for this reach, illustrated in **Figure 4.53**, shows that the flows entering this reach from upstream exceed the outflows for most of the period. Since the canal stage generally exhibits a decreasing trend, this seems to indicate that these inflows are escaping into the groundwater system east of this reach. This practice tends to route water from upstream, primarily from NESS, and delivers it to the aquifer of south Miami-Dade County. It is also interesting to note that this reach begins to show drainage of the adjacent marsh only when S-331 is turned off in mid-March. This is drainage from the west. However, this process is happening even when the inflows to the canal reach exceed the outflows and only becomes apparent when the inflows stop.

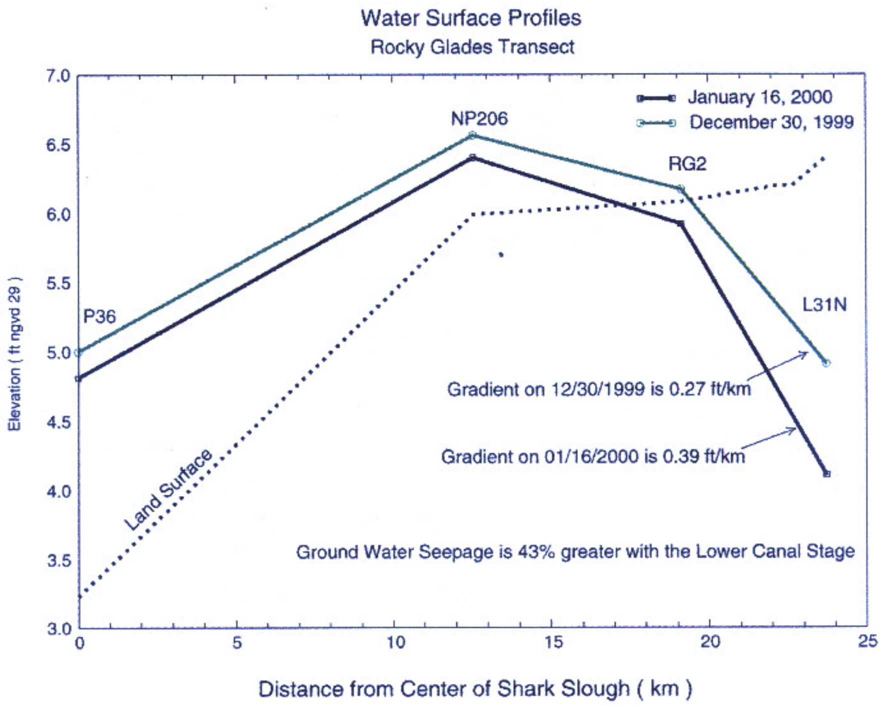


Figure 4.51. Water surface profiles.

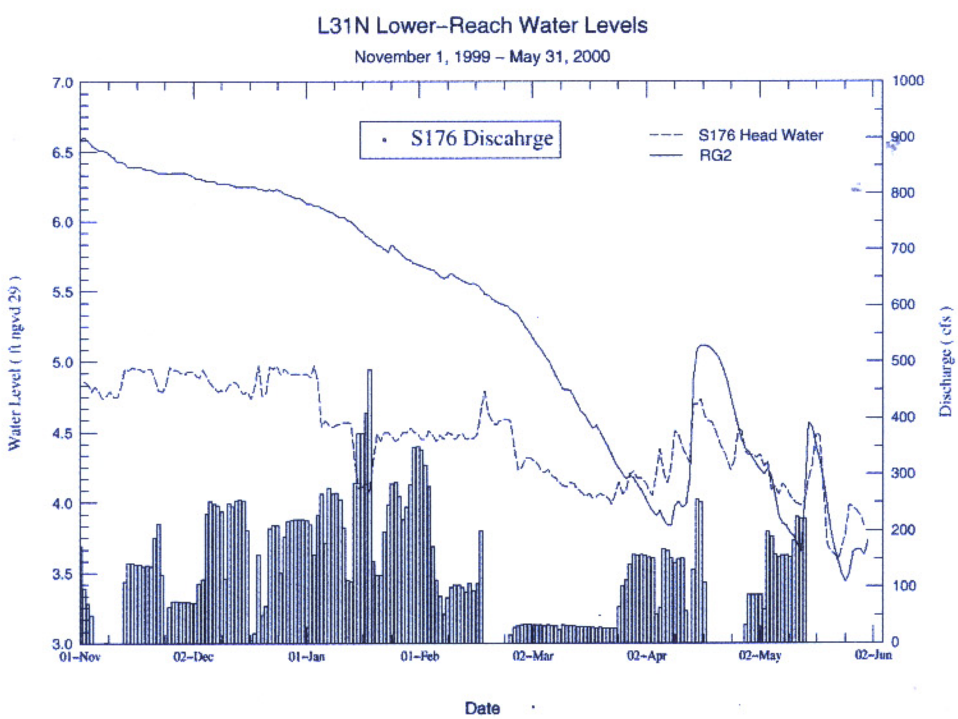


Figure 4.52. L-31N lower-reach water levels, Nov. 1, 1999– May 31, 2000.

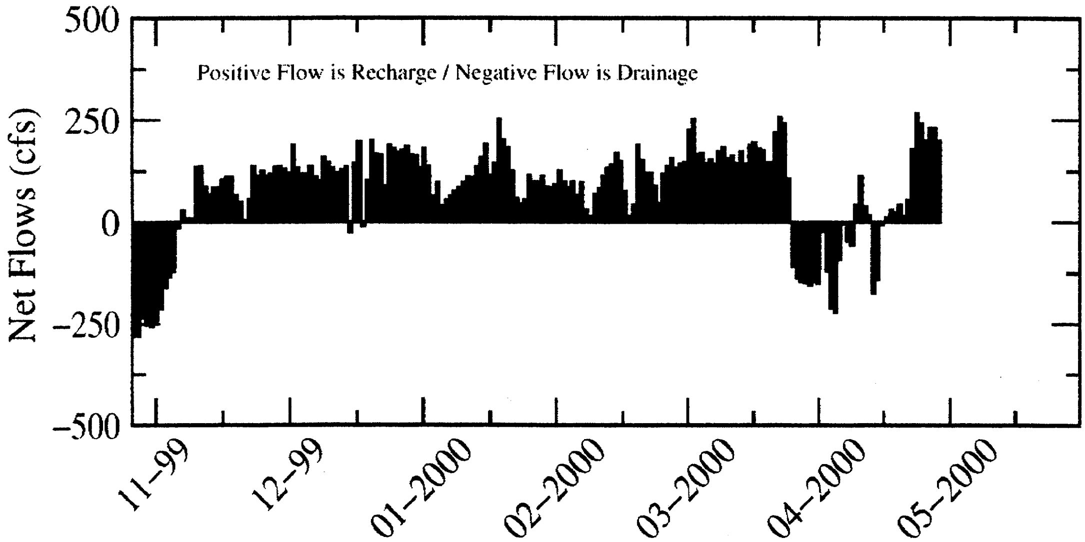


Figure 4.53. L-31N low net flows.

4.5.2.1.6 L-31W

The flow budget for L-31W indicates that the reach discharged approximately 68,000 acre-feet more that was delivered. Much of this excess was drained from the northern part of the slough and delivered south via S-332. **Figure 4.54** illustrates the hydrology of this area for the period. The figure clearly shows the dominance of water management operations on conditions in L-31W and Taylor Slough. From November 1^{st} to February 17^{th}, water levels did not vary at all in the slough. This was a result of maximum discharges at S-332 and S-332D during this time, which maintained constant high water levels. These two pump stations were being used in conjunction with the other SDCS structures to move water out of WCA-3A and through the SDCS. Then in mid-February there was a precipitous drop in water levels over the President's Day holiday weekend. This rapid water level drop was caused by cessation of water management operations that had kept the water level in Taylor Slough steady for months. Meanwhile, surrounding water levels were receding. When the pump was abruptly stopped water levels in the slough plummeted.

Figure 4.55 shows the net flow for this reach of canal. Drainage was very strong until the cessation of pumping at S-332. Another clear but not surprising illustration of the dominance of S-332 over the hydrology of this reach.

These water management operations had a severe negative impact on the habitat of Taylor Slough. **Figure 4.56** shows this years' stage hydrograph along with others from selected years. The hydrographs were normalized by equating the stage on November 1^{st} of the selected year to the stage on November 1, 1999. This allows for more direct visual comparison. From the plot it is clear that the recession rate of this year is unprecedented and is only approached by last year's operations.

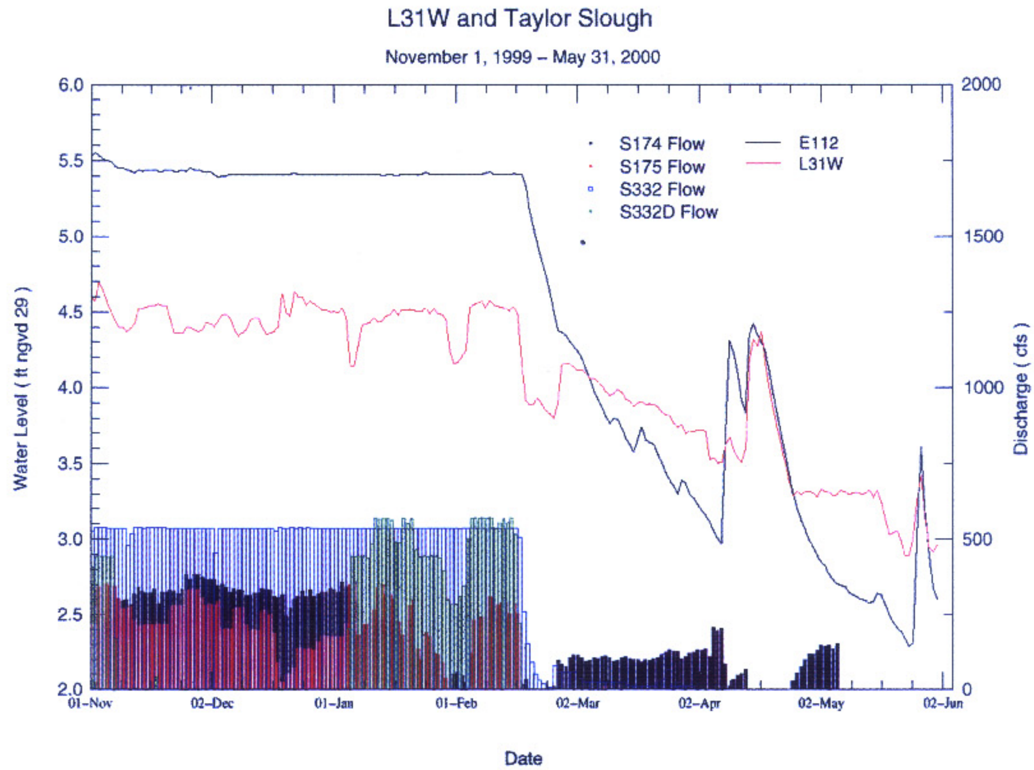


Figure 4.54. L-31W and Taylor slough flows, Nov. 1, 1999– May 31, 2000.

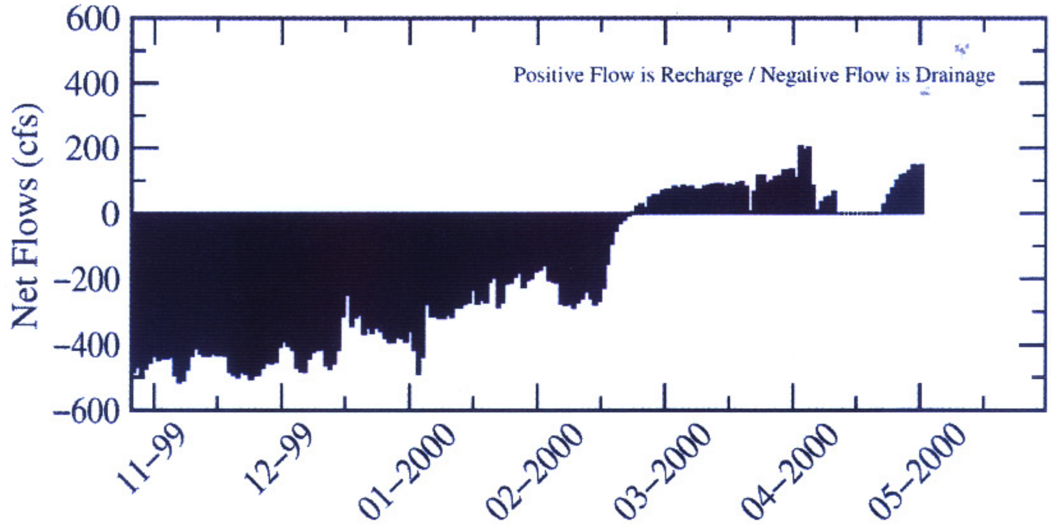


Figure 4.55. L-31W net flows.

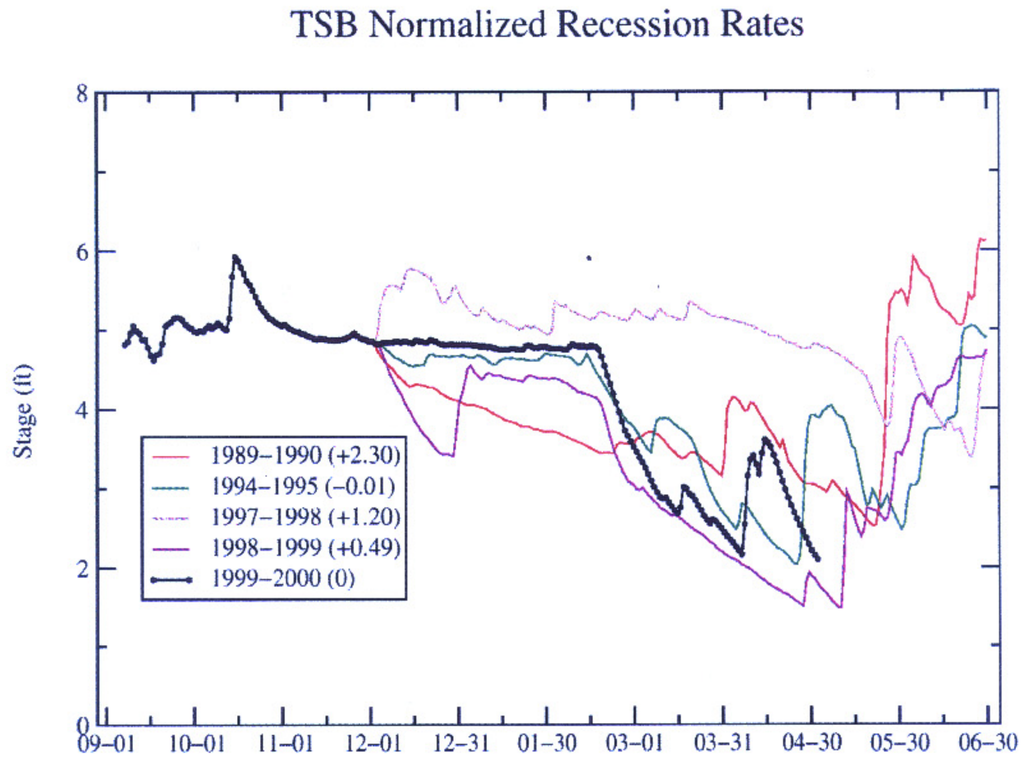


Figure 4.56. Normalized recession rates at Taylor Slough Bridge (TSB).

4.5.2.1.7 Upper C-111

This reach consists of the C-111 canal between S-176 and S-177. During this period, outflows were slightly higher than inflows with a net loss of approximately 4,000 acre-feet. **Figure 4.57** is a plot of the net flow from the reach. Review of this figure and **Figure 4.58** shows some interesting features. When the net flow indicates drainage, the stage in this reach begins to drop. However, when the drainage stops in mid-February, corresponding to the drop in Taylor Slough, the stage in this reach continues to recede at similar rate. This could indicate that Taylor Slough, which was 2 feet higher than the stage in this reach, was supporting these higher water levels. When S-332 was turned off, water levels began to reach a new equilibrium with the S-177 tailwater.

4.5.2.1.8 Middle C-111

This reach, between S-177 and S-18C, drained an additional 11,000 acre-feet from the basin. Much of this water came from drainage of Taylor Slough. **Figure 4.58** shows the S-177 tailwater and the S-18C headwater. **Figure 4.59** illustrates the net flow for this reach. This reach was in a drainage mode for most of the period, with flows at S-18C typically exceeding flows at S-

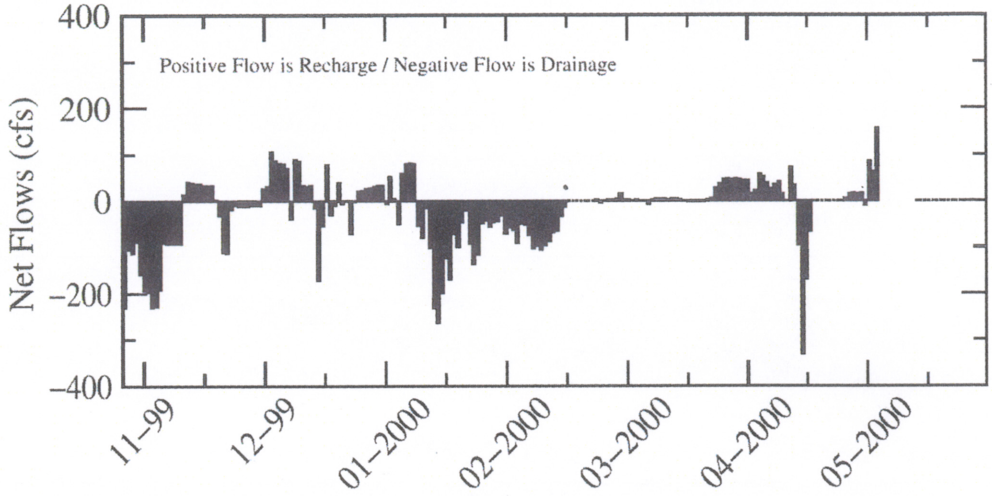


Figure 4.57. C-111 upper net flows.

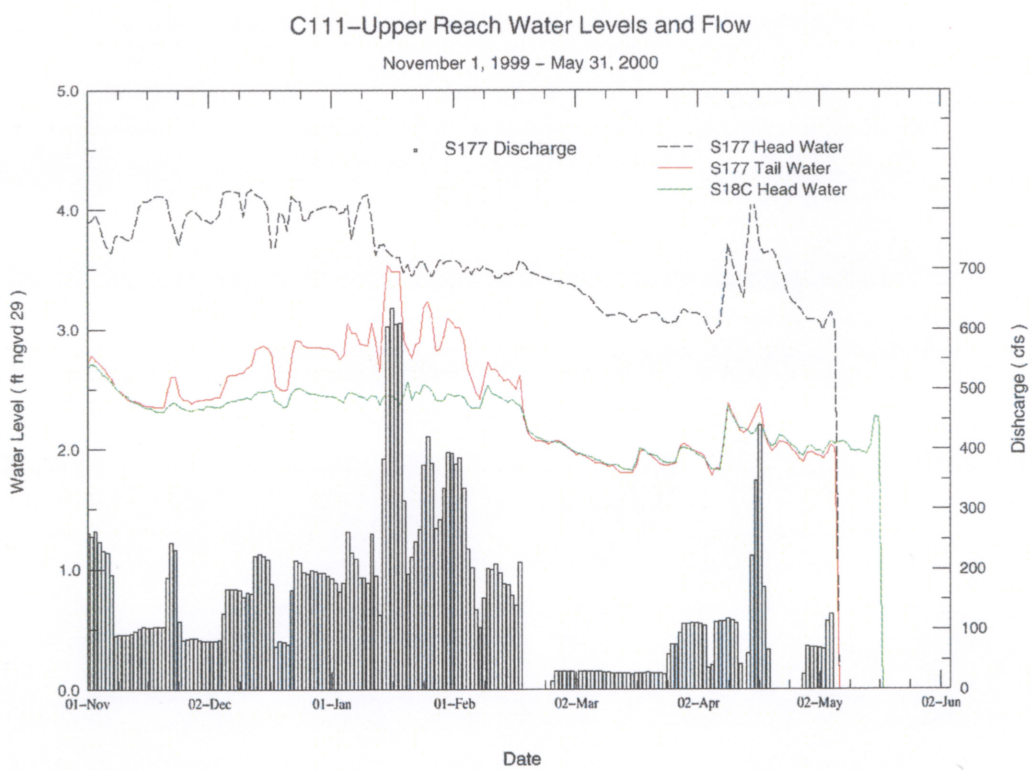


Figure 4.58. C-111 upper-reach water levels and flows, Nov. 1, 1999– May 31, 2000.

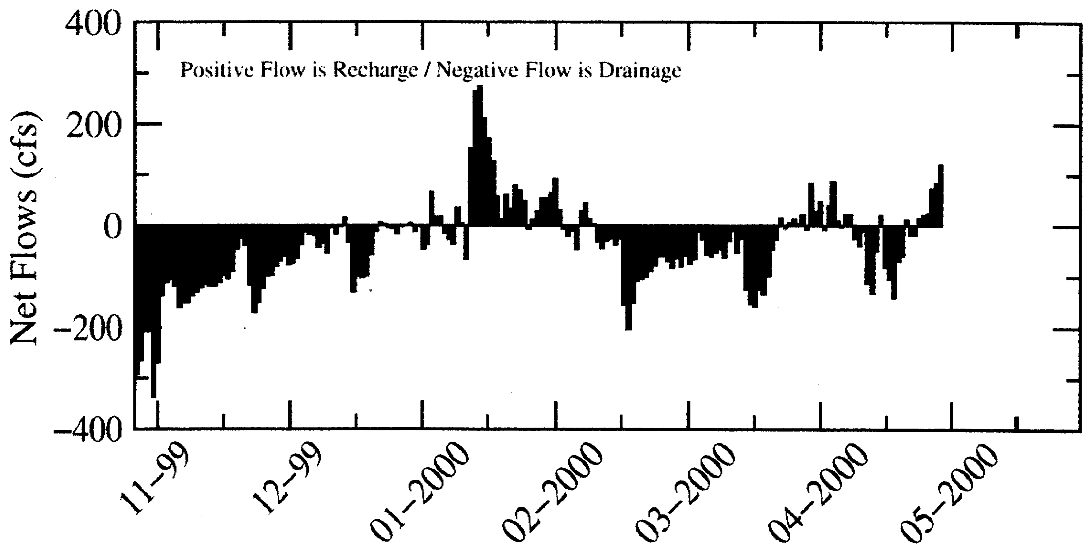


Figure 4.59. C-111 mid net flows.

177. The exception was a short period in January. This resulted in drainage of the reach above S-18C, simply transferring water to the canal reach below S-18C, effectively short circuiting natural conditions.

4.5.2.1.9 Lower C-111

S-197, the outlet for this reach, was shut for the entire period, while S-18C passed 64,000 acre-feet of water. This water entered the marsh of the Eastern Panhandle over the C-111 downstream bank. **Figure 4.60** shows S-18C flows along with stages in marsh at EVER6 and EVER7. The figure clearly shows the marsh response to S-18C discharge. **Figure 4.61** shows the net flow for this reach. This reach of C-111 tends to drain water from Taylor Slough and the Mid and Upper C-111 basins and shunts it to the Eastern Panhandle. This drainage will be exacerbated by planned operations. Under the Experimental Water Deliveries Program, operations dictated that this structure open at 2.6 feet and close at 2.3 feet. The S-18C headwater receded to 2.3 feet on February 20, 2000, yet S-18C remained open. Operational plans for this structure will lower the criteria to open at 2.25 feet and close at 2.0 feet. This is apparently to help avoid using S-197. However, use of S-197 during the dry season is an unlikely event.

4.5.2.2 Hydrologic Analysis of the 2000 Wet Season

A particular concern for ENP is the wet season operations that route water from S-335 to ENP when no water is being brought from the WCAs. This operation continued from June through December. The effects of these operations are:

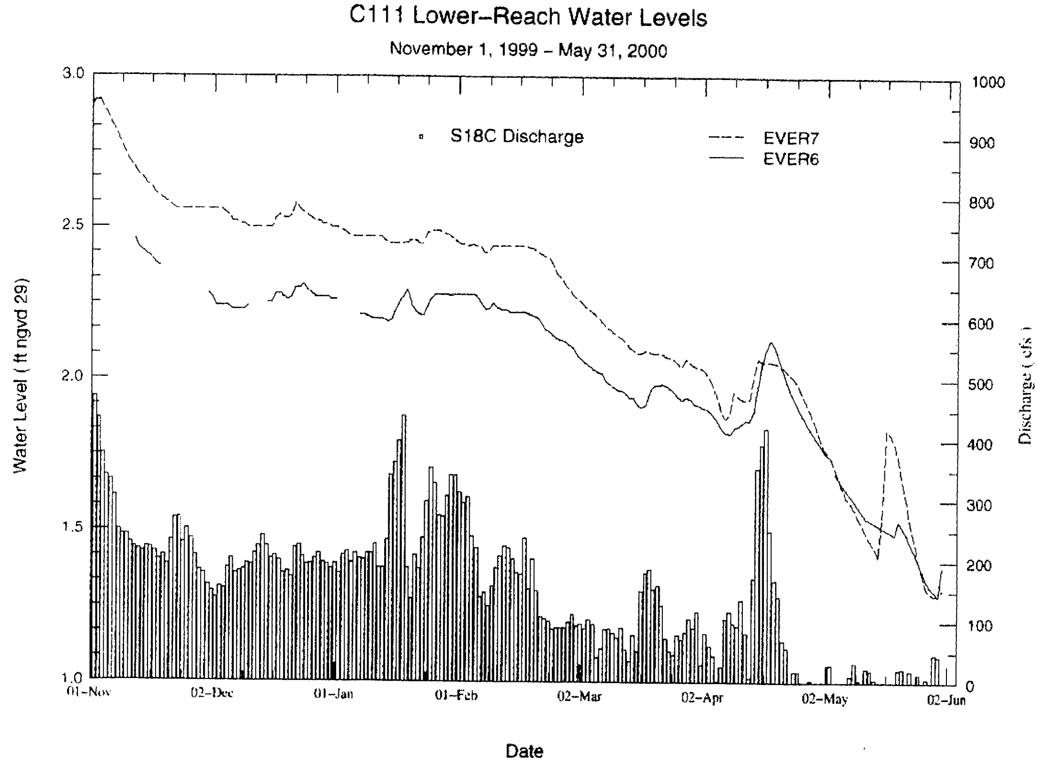


Figure 4.60. C-111 lower-reach water levels, Nov. 1, 1999-May 31,2000.

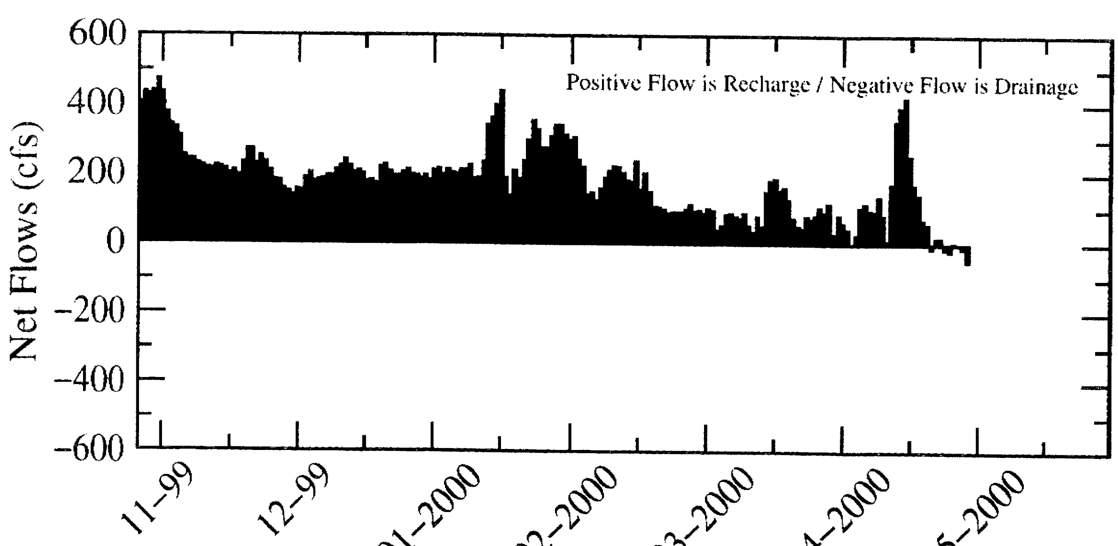


Figure 4.61. C-111 low net flows.

- Delivery of high phosphorous loads into ENP via S-332D and S-332B.
- Increased drainage of NESS.
- Increased drainage of WCA-3B.
- Increased flood flows to the lower C-111 basin and Eastern Florida Bay.

Figure 4.62 is a structure budget map for the period between October 4th and November 5th. This corresponds to a period of large discharges through S-335, when stages in L-30 were held 0.5-1.0 feet lower than in previous years, draining WCA-3B and the Pennsuco wetlands **(Figure 4.63)**. By comparing **Figure 4.64 and Figure 4.65** it is apparent that under the ISOP, L-30 drains WCA-3B and the Pennsuco wetlands. At the same time that WCA-3B was being drained, S-332B was overflowing, delivering high concentrations of phosphorous to ENP. Although S-332D was permitted to deliver water from WCA-3A via S-334 and S-337, (**Figure 4.66** S-332D operations during ISOP) reveals that for most of the time that S-332D was pumping, S-334 and S-337 were not providing flow to the SDCS.

In January and February S-332D pumping was concurrent with the opening of S-334. However from July through October, under the wet season operations, S-332D was used when no water was being released through either S-334 or S-337. Instead S-332D was operated to route flows from S-335 and S-331. In essence this wet season operation used S-332D to route flood waters from WCA-3B, the Pennsuco Wetlands, NESS and the 8.5 Square Mile Area into ENP. In a water quality analysis, included in **Appendix B.**, ENP staff have reviewed data provided by the Corps and concluded that these flood discharges contained high levels of phosphorous that could lead to changes in vegetative communities in ENP **(Figure 4.67)**.

The distribution of flows to ENP and seepage from ENP for this time period is shown in **Figures 4.68 and 4.69**. These figures reveal that these wet season operations allow for no water deliveries to NESS while removing a volume of water from NESS that is equal to 33% of the water seeping from ENP during that same time period. Prior to the ISOP, during the wet season, G-211 was closed when S-331 was pumping, allowing flood-water to be removed from the 8.5 Square Mile Area without draining NESS. Although the headwater specification for G-211 is to open at 6.0 feet, the Test 7 EA recognized that, "during flood control operations, or when making water supply deliveries, stages outside this range, either high or low, may occur for extended periods of time."

Under the ISOP, the upper end elevation for G-211 is reduced from 6.0 feet to 5.8 feet, and is tightly maintained by routing water from G-211 through S-331 and into S-332B, S-332D and S-197. Comparison of **Figures 4.70 and 4.71** reveal the reductions in NESS stage at the NE2 gage that accompany lowering of the G-211 headwater. These reductions in wet season stage in WCA-3B and NESS represent a loss of water from storage and undesirable transfer of this volume to the southern end of ENP, or worse, to tide. This is a direct contradiction of the natural flow regime in which water is delivered more evenly as sheet flow through NESS to the Rocky Glades, Taylor Slough and Florida Bay. This operation effectively short-circuits the slower natural flow path through NESS and the Rocky Glades. The effects of the ISOP operations on NESS and the eastern side of ENP are revealed by calculating canal water budgets for each of

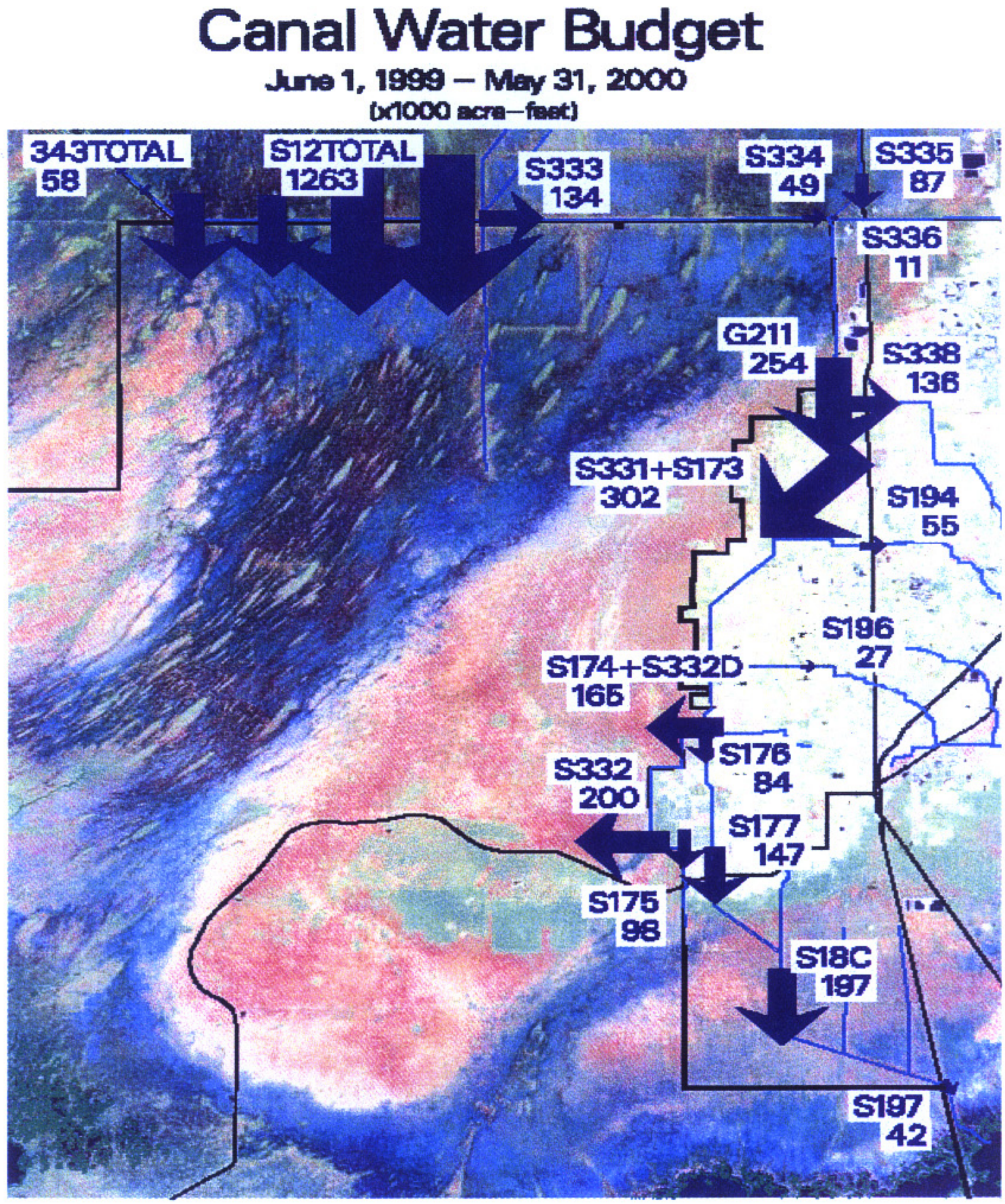


Figure 4.62. Canal water budget for pre-ISOP wet season and ISOP dry season (1999-2000).

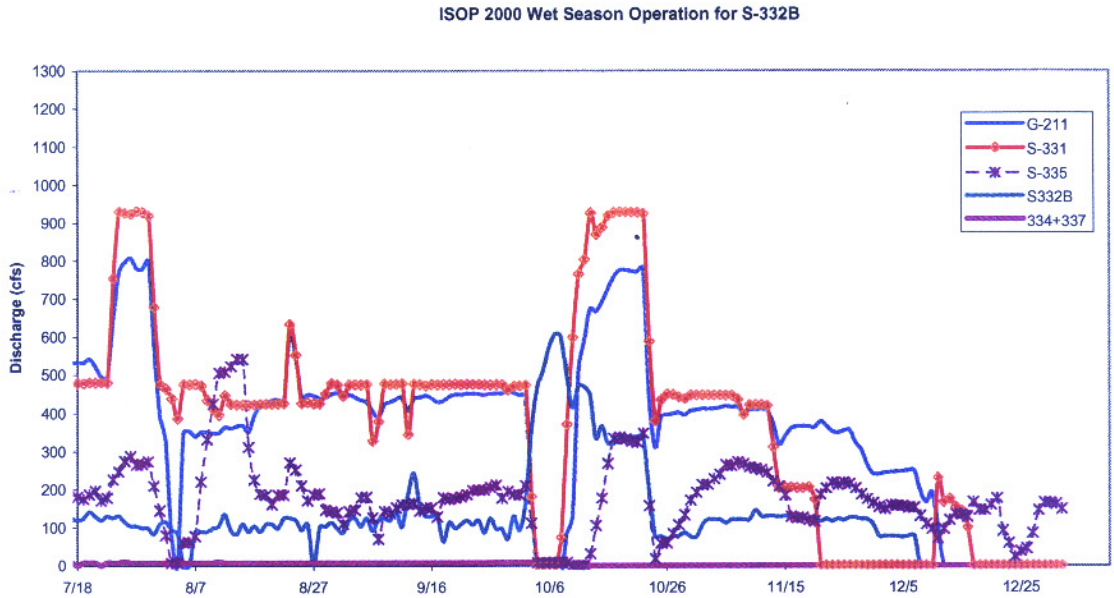


Figure 4.63. ISOP wet season operation for S-332B.

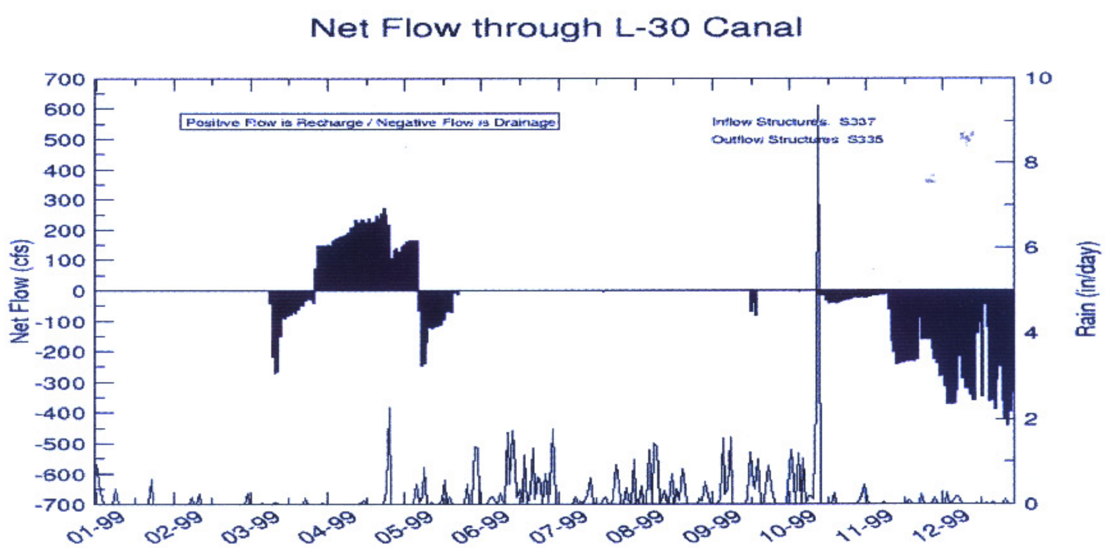


Figure 4.64. L-30 canal seepage before ISOP.

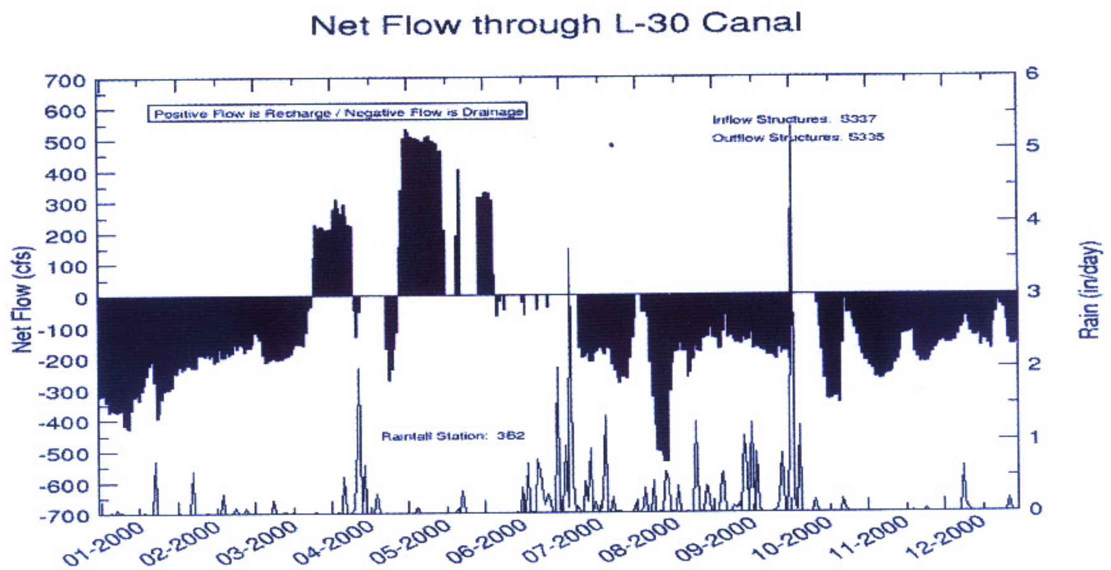


Figure 4.65. L-30 canal seepage during ISOP.

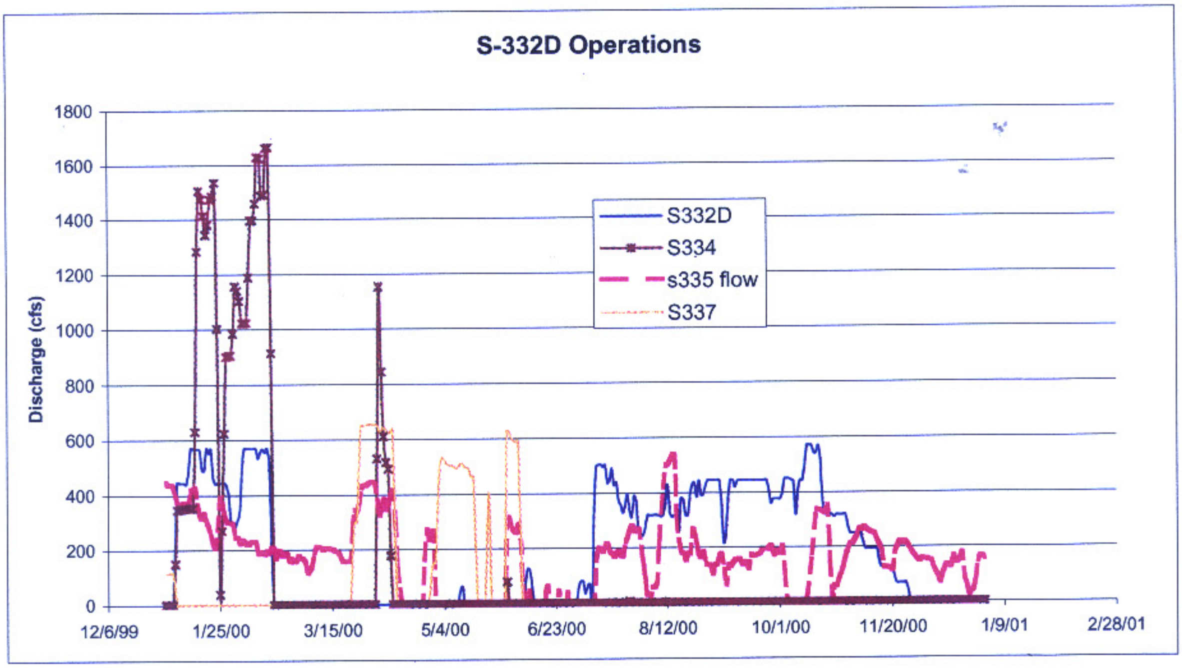


Figure 4.66. S-332D operations during ISOP.

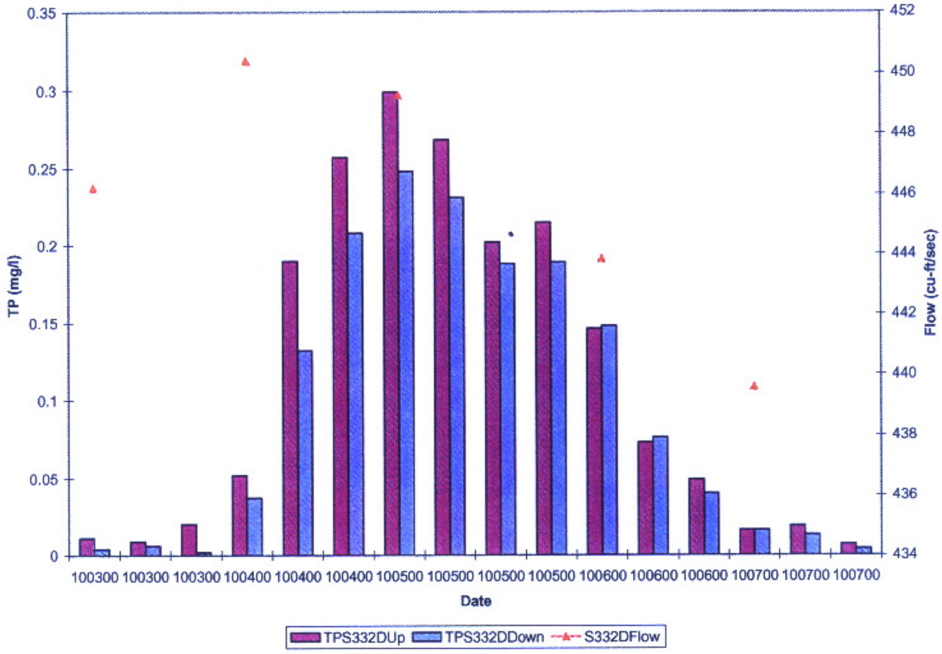


Figure 4.67. Flow and total P concentration at S-332D during October 2000 storm.

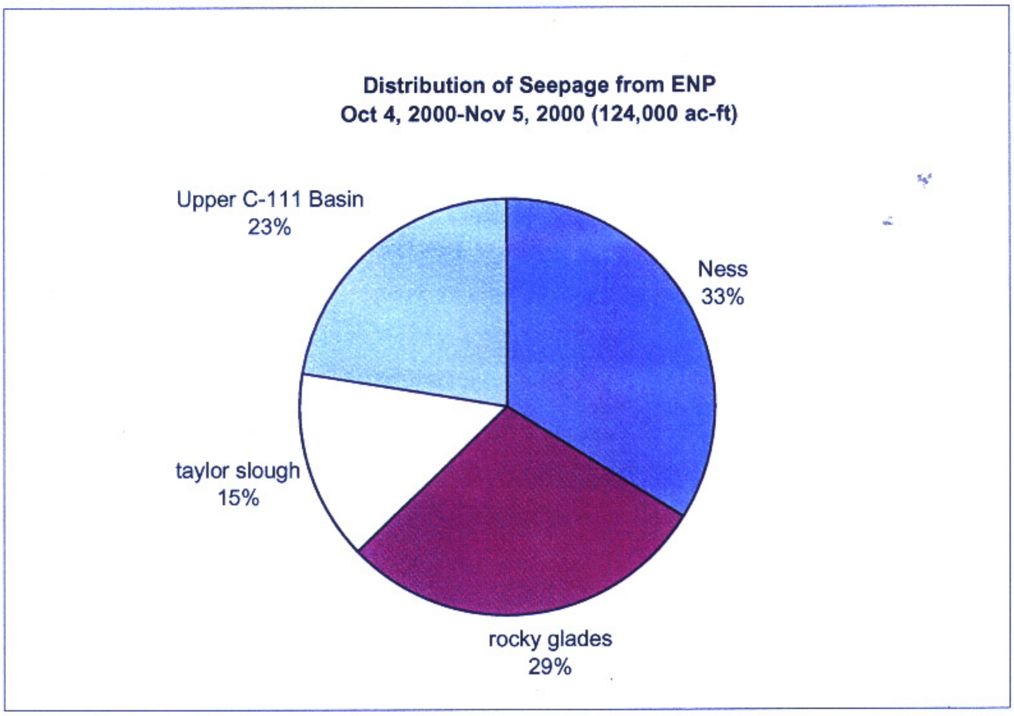


Figure 4.68. Distribution of seepage from ENP following October storm event.

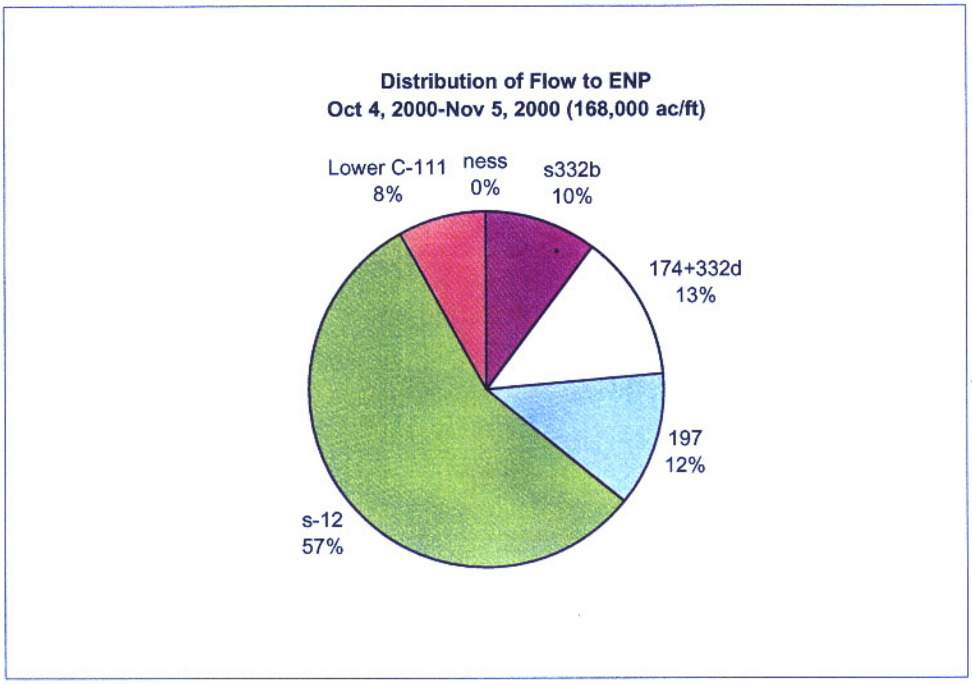


Figure 4.69. Distribution of flow to ENP following October storm event.

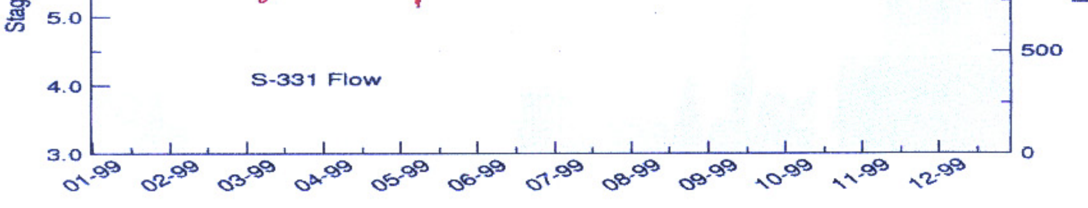


Figure 4.70. L-31N operations and NESS stage during 1999.

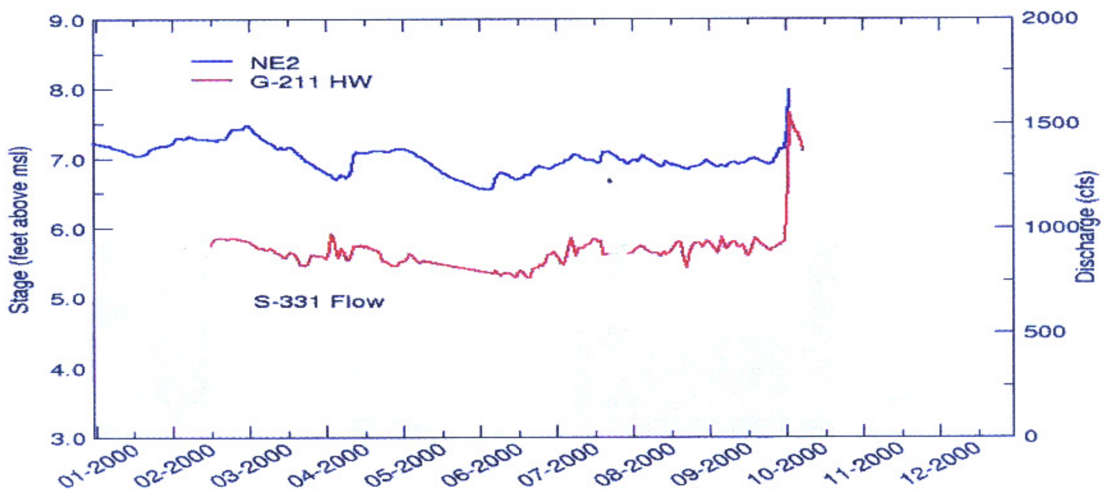


Figure 4.71. L-31N operations and NESS stage during 2000.

the reaches. Reach budget calculations for the late 2000 wet season (October 4 through November 5), following the "No-Name" storm are presented in **Figure 4.62**. Water removed from NESS is routed through the SDCS and re-introduced to the park at two major locations, S-332D and Lower C-111 canal.

4.5.3 Effect of ISOP in CSSS Sub-populations

The effect of the ISOP on NESS can be ascertained by comparing the monthly stage at monitoring stations NE1 and NE2 during the 2000 calendar year to the average stage at these monitoring stations during the experimental program **(Figure 4.72 and Figure 4.73)**. The effect of maintaining higher dry season stages in the L-29 canal and of S-333 inflows to NESS can be seen at both NE1 and NE2. Despite the dry conditions during 2000, the stages at both NE1 and NE2 are higher than average. These results indicate that although overall flow to Shark Slough has been decreased, during this dry period, the ISOP operations have had some beneficial effect on stages in NESS.

The effects of the ISOP on CSSS sub-populations can be ascertained by determining stage, hydroperiod and nesting days for each sub-population and placing these measurements in context of previous stage (1986-2000), hydroperiods and nesting days using the concept of a return period. Sub-population B is not addresses here because the ISOP had no discernable hydrologic effect in this area

4.5.3.1 Western Sub-populations

4.5.3.1.1 CSSS Sub-population A (Western Shark Slough)

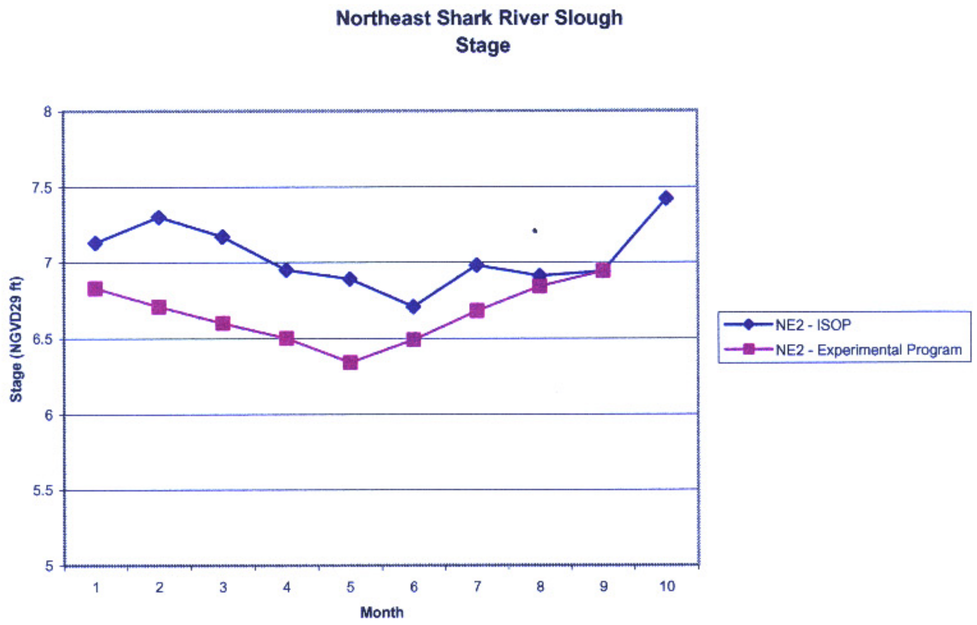


Figure 4.72 Average monthly stage in NESS during Experimental Program and during ISO, measured at NE2

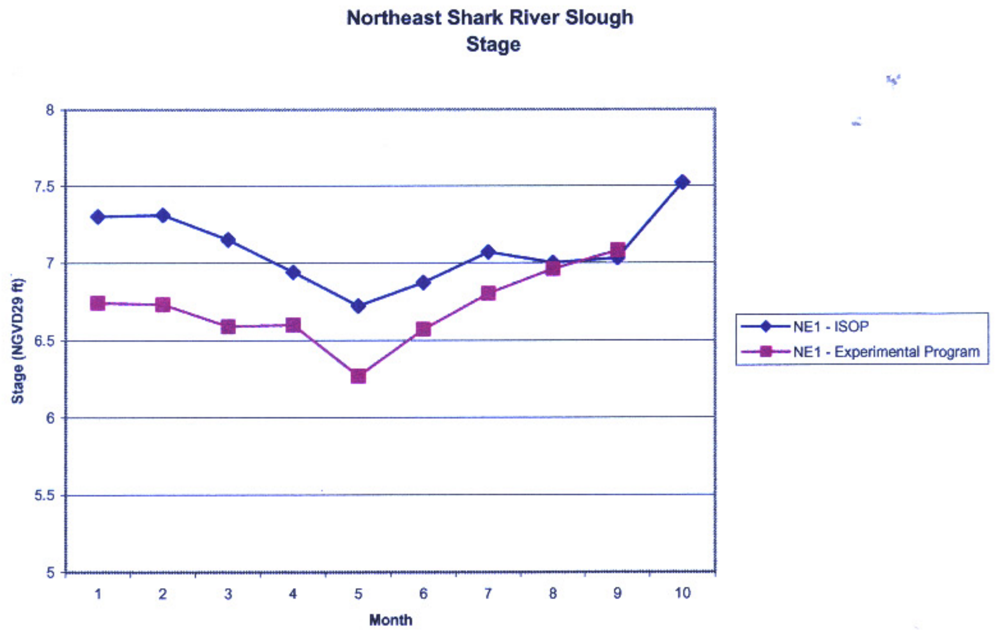


Figure 4.73. Average monthly stage in NESS during Experimental Program and during ISOP, measured at NE1

ISOP operations did not provide 60 consecutive days of water levels at or below 6.0 feet at the NP-205 gage, as required by the RPA. Water levels at NP-205 dropped below 6.0 feet on March 5, 2000, but on April 14, 2000, at approximately 17:00 hours, water levels at NP-205 were recorded at 6.01 feet for a total of 40 consecutive days below 6.0 feet. Water levels continued to rise over the next several days, reaching a peak reading of 6.14 feet. On April 26, 2000, between 1:00 and 2:00 hours, water levels at NP-205 dropped back below 6.0 feet but remained below for only 44 consecutive days, until June 9, 2000. **Figure 4.74** shows the percent of habitat availability for sub-population A based on the stage at NP-205. As shown in this graph the mid-April rainfall event caused over 60% of the habitat to be unsuitable during the middle of the nesting season.

From March through December, the average monthly stages in CSSS sub-population A were lower in 2000 than during the previous years **(Figure 4.75)**. Nesting days were calculated for the sub-populations by determining the number of continuous days in which the water level was below the ground surface during the breeding season, which extends from February 15th through July 15th. The number of nesting days observed at NP-205 **(Figure 4.76)**, corresponds to a "1-in-3" dry year return period for rainfall. The discontinuous hydroperiod measures the number of days that the water level was above the ground surface. This measurement is an important indicator for fire risk and vegetative cover. The discontinuous hydroperiod of 287 days corresponds to between a "1-in-5" to "1-in-3" dry year for the 1986-2000 period of record **(Figure 4.77)**.

4.5.3.2 Eastern Sub-populations

ISOP operations appear to have provided 3-4 months of nesting habitat availability in sub-populations C, D, E and F, consistent with RPA requirements. For the eastern CSSS habitats, the RPA requires water level and hydroperiod increases equivalent to Test 7 Phase II operations. Current ISOP wet season operations have not met these requirements in the sub-population E and F habitats, primarily due to limited success in operating the new S-332B pump and retention area. Operations conducted at this pump have resulted in increased water levels in only a fraction of the sub-population F habitat, with decreases in water levels in other portions of the sub-population F habitat adjacent to L-31N. No effect has been observed in the sub-population E habitat due to S-332B operations.

Hydrologic modeling of ISOP9D suggests that future implementation of ISOP9D would meet wet season water level targets in sub-population C-F habitats. However, this modeling assumes S-332B performance that is not currently possible. Until observed performance at S-332B can be demonstrated to match modeled performance, we conclude that future ISOP9D implementation would fail to meet wet season RPA targets in sub-populations E and F.

ISOP9D operations appear to meet RPA wet season water level targets in sub-populations C and D. The RPA does not require any changes in habitat conditions in sub-population B, and no change due to ISOP9D operations has been observed in this area.

4.5.3.2.1 CSSS Sub-population E (Eastern Shark Slough)

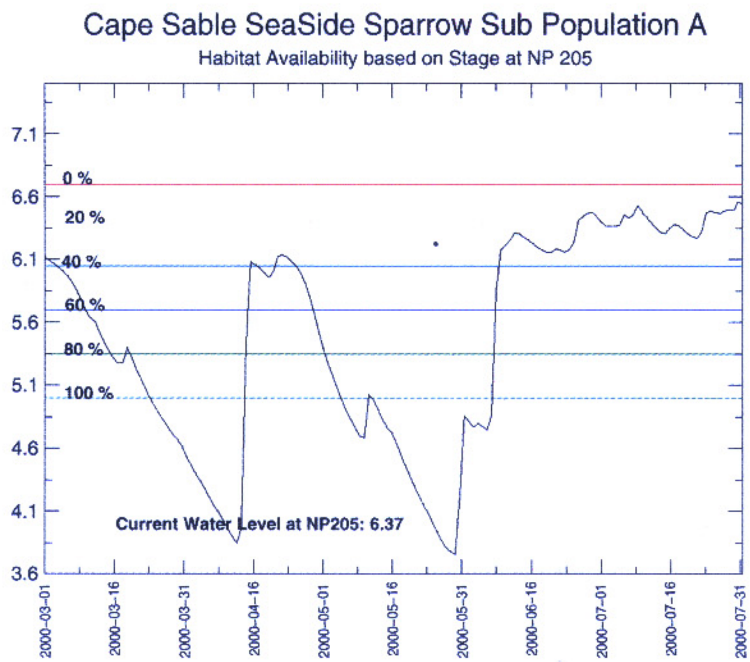


Figure 4.74. NP-205 hydrograph with percent sparrow habitat.

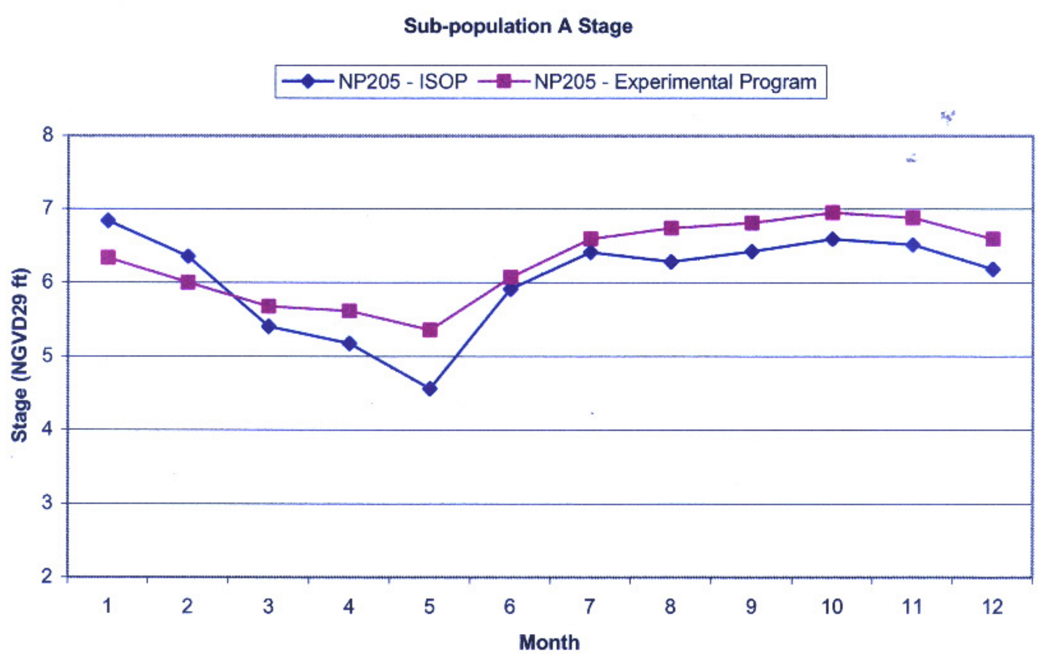


Figure 4.75. Average monthly stage in CSSS sub-population A during Experimental Program and during ISOP.

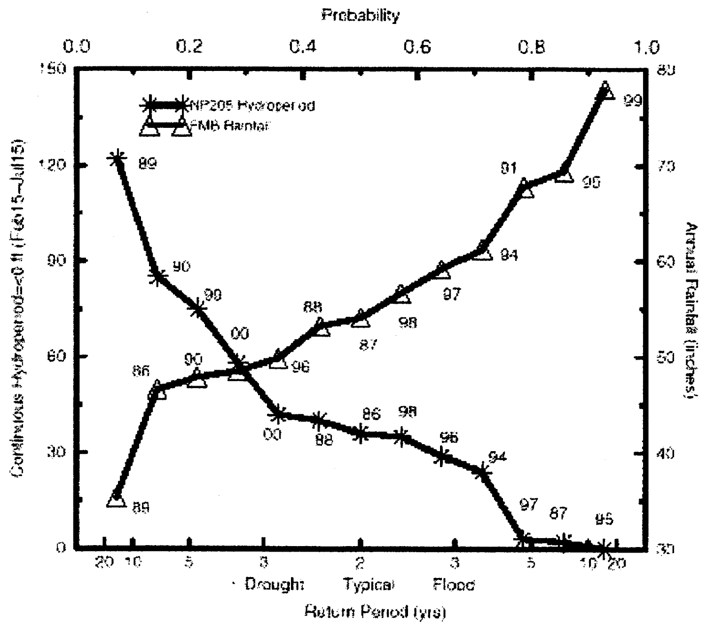


Figure 4.76. Probability distribution for consecutive days when water table is below the ground surface between Feb. 15 and July 15 at NP-205 (CSSS sub-population A).

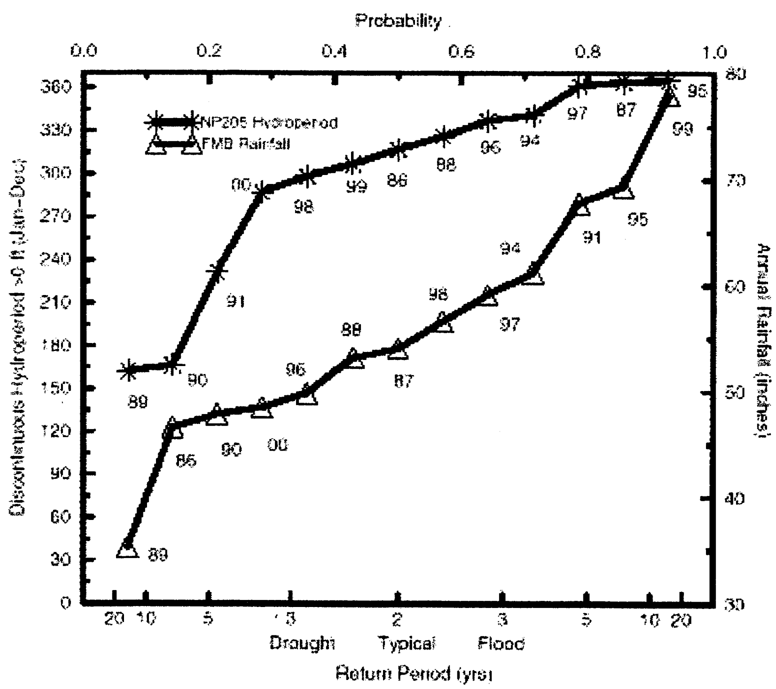


Figure 4.77. Probability distribution for annual rainfall and number of days when water level is over the land surface at NP-205 (CSSS sub-population A).

Monthly average stages in CSSS sub-population E are determined at two monitoring sites, NP-206 and A-13 **(Figure 4.78)**. A-13 is located on the western site of the habitat, near SRS, while NP-206 is located in the northern part of the habitat. Stage at NP-206 was significantly higher than the previous years during the months of January through April. This increase in stage is most likely due to the combined effects of, high antecedent stages due to Hurricane Irene, and the combination of increased flows to NESS and higher stages in L-29. Stage at NP-206 during the latter part of the year was unchanged relative to previous years. Stage at A-13 was un-changed relative to the previous years' average. There were 121 nesting days at NP-206 which corresponds to return period for a "1-in-3" dry year **(Figure 4.79)**. However the discontinuous hydroperiod of 205 days corresponds to a "1-in-2" year return period or an average year **(Figure 4.80)**. The longer hydroperiod is due to the higher than average stages from January though May related to Hurricane Irene. Both the hydroperiods at NP-206 and A-13 indicate that, at these stations, the habitat experienced the needed hydroperiod and nesting days during the 2000 dry season. The hydroperiods were slightly above the 180 day maximum for long-term sustenance suitable CSSS habitat.

4.5.3.2.2 CSSS Sub-population F (Southern Rocky Glades)

Stages at G-3273, RG-2, and Rutzke represent the range of stages that occur across this habitat **(Figure 4.81)**. Stages did not change appreciably across most of the habitat, with the exception of G-3273, which was higher than previous years during the first 5 months of the year, due to the high antecedent stage from Hurricane Irene. Another notable exception is the high stages at all sites corresponding to the heavy rainfall event in early October. Both sites provided an adequate number of nesting days, corresponding to a "1-in-2" year return period or an average year **(Figure 4.82)**. Again, one needs to consider both the rainfall for the 2000 dry season and the extremely wet antecedent conditions of 1999. If hydroperiods at G-3273 and Rutzke are to be considered representative of sub-population F, then it is too dry **(Figure 4.83)**. Examination of **(Figure 4.84)** suggests that the rainfall associated with the "No-Name" storm in the first week of October contributed to a large percentage of the hydroperiod as days measured with water above the ground surface.

4.5.3.2.3 CSSS Sub-population C (Taylor Slough)

Stages in CSSS sub-population C are represented by measurements at R-3110 and NTS1 **(Figure 4.85 and Figure 4.86)**. Stages in this habitat have increased relative to previous years for all months except the month of May. These changes in stage indicate that there is an im-provement in providing water to this over-drained area as a result of the implementation of S-332D and the removal of the constraint on the stage in the L-31W canal. This improvement in stage has not significantly reduced the number of nesting days **(Figure 4.87)** due to the con-straint on S-332D flows during the CSSS nesting season. An increase in the hydroperiod at these locations **(Figure 4.88)** resulted primarily from the removal of the L-31W stage constraint and the ability to increase flows to L-31W with the operation of S-332D. These operations are intended to move flows west to Taylor Slough as opposed to the C-111 basin or to tide.

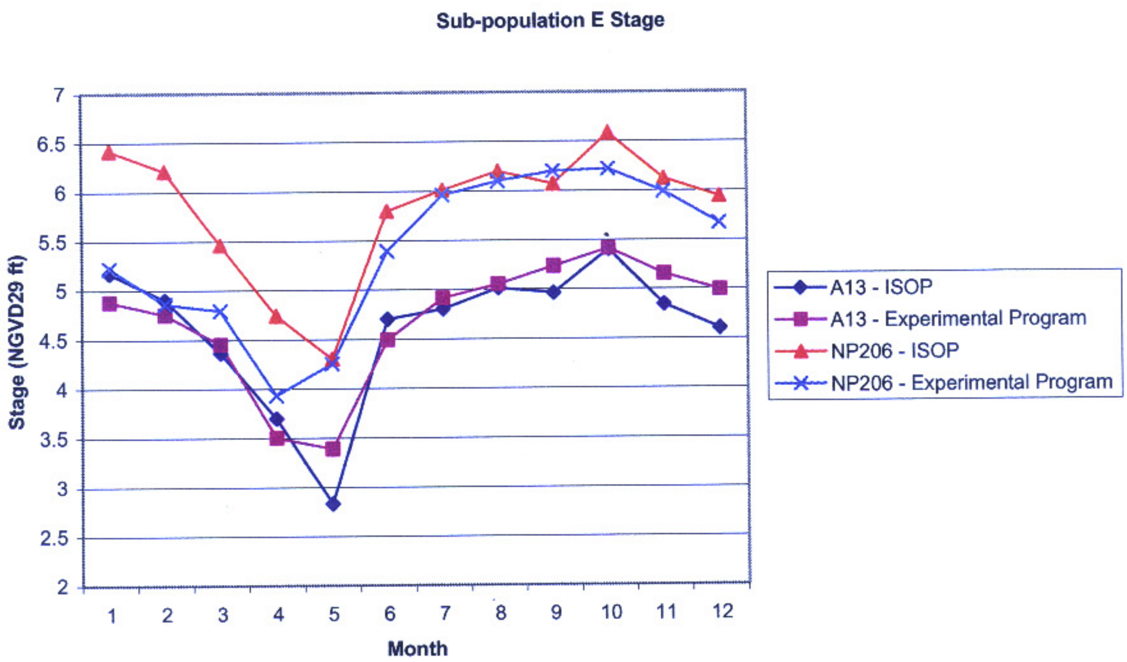


Figure 4.78. Average monthly stage in CSSS sub-population E during Experimental Program and during ISOP.

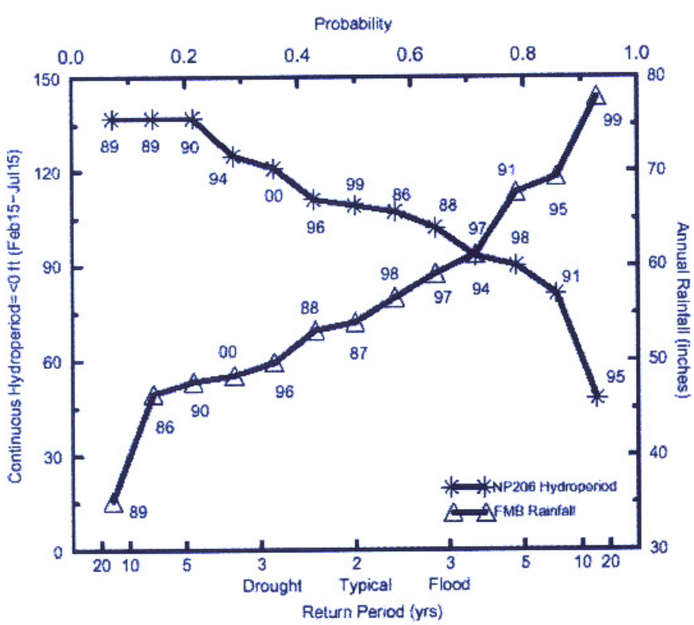


Figure 4.79. Probability distribution for consecutive days when water table is below the ground surface between Feb. 15 and July 15 at NP-206 (CSSS sub-population E).

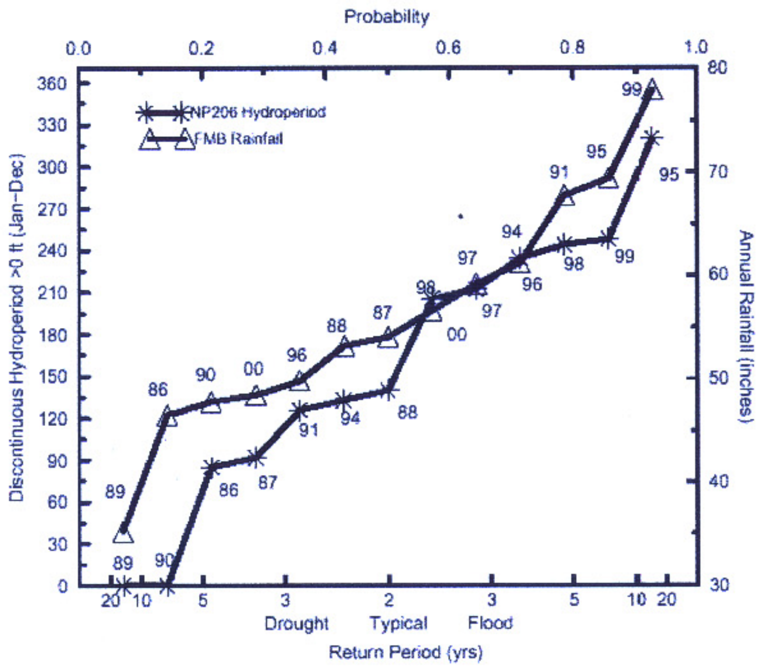


Figure 4.80. Probability distribution for annual rainfall and number of days when water level is over the land surface at NP-206 (CSSS sub-population E).

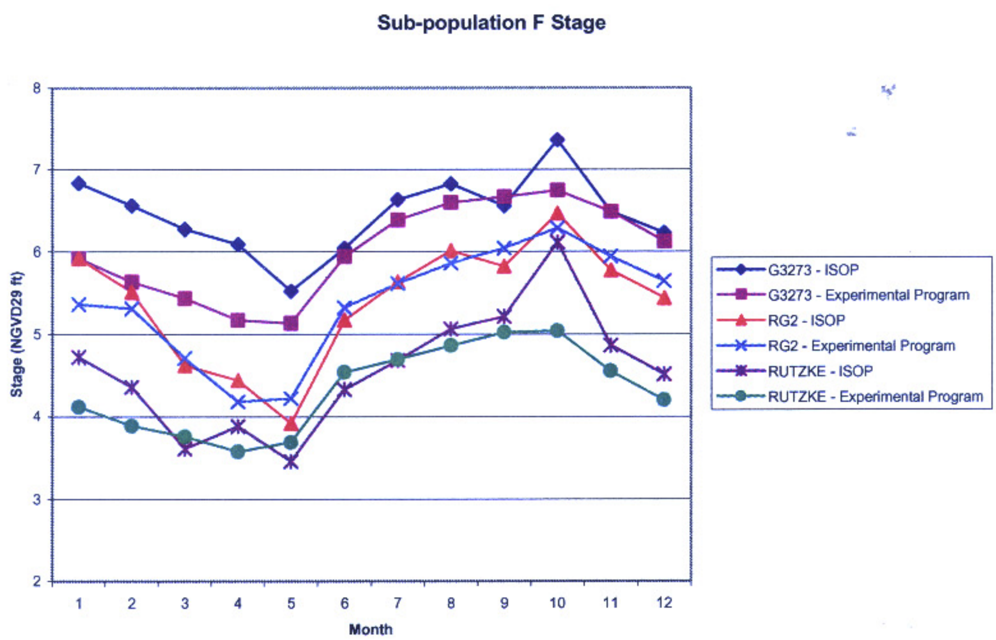


Figure 4.81. Average monthly stage in CSSS sub-population F during Experimental Program and during ISOP.

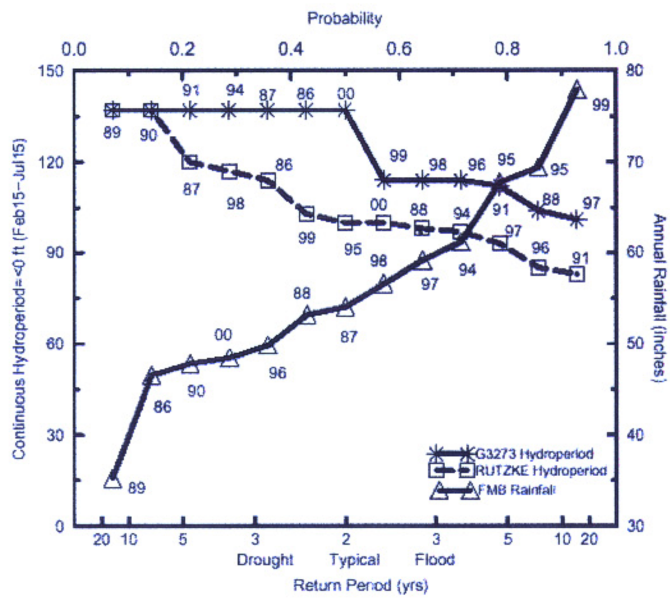


Figure 4.82. Probability distribution for annual rainfall and consecutive days when water table is below the ground surface between Feb. 15 and July 15 at for CSSS sub-population E.

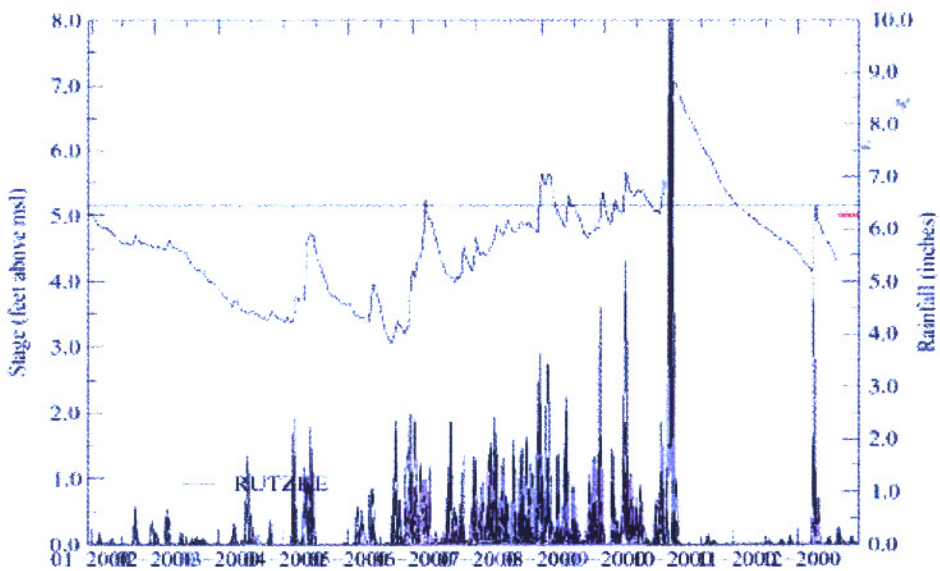


Figure 4.83. Rutzke stage and rainfall with ground surface elevation.

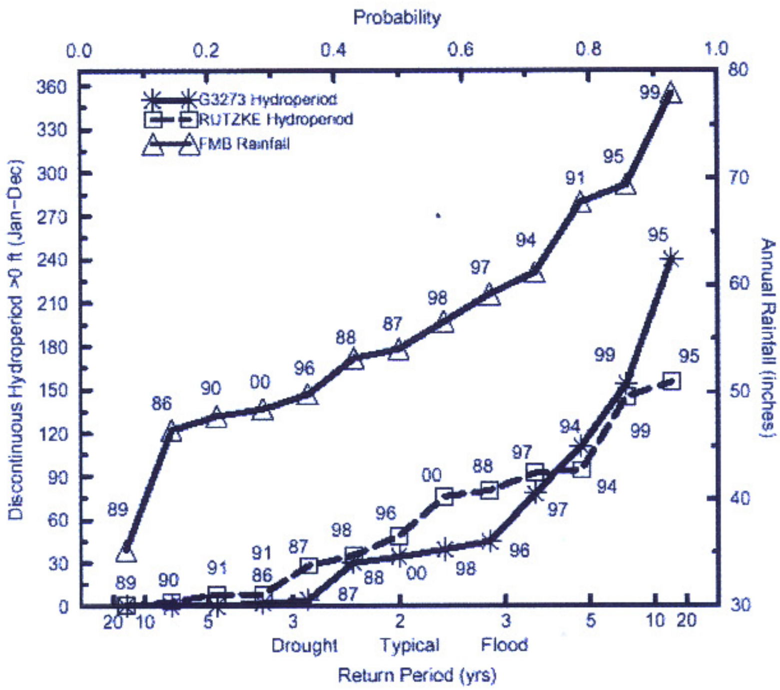


Figure 4.84. Probability distribution for annual rainfall and number of days when water level is over the land surface for CSSS sub-population F.

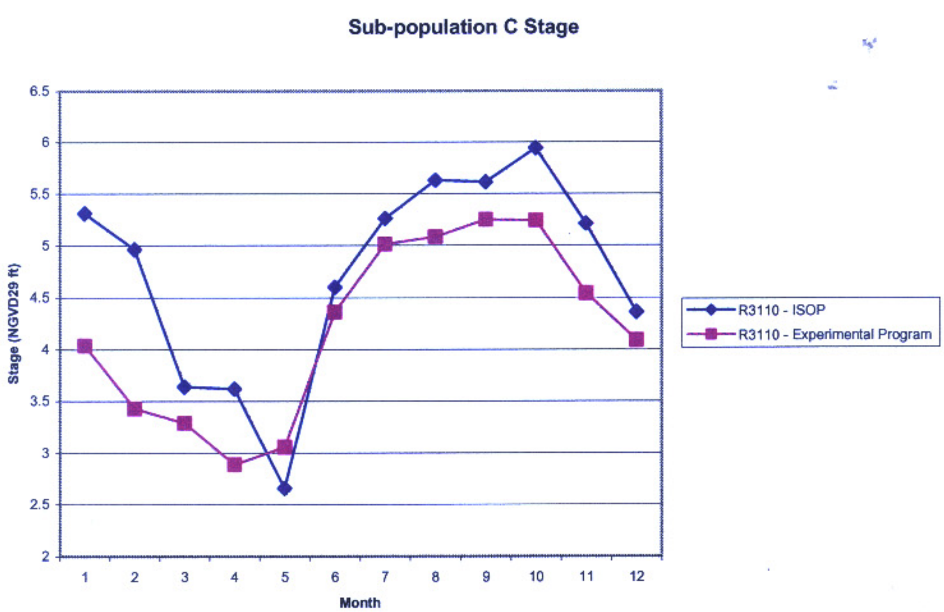


Figure 4.85. Average monthly stage in CSSS sub-population C during Experimental Program and during ISOP, measured at R3110.

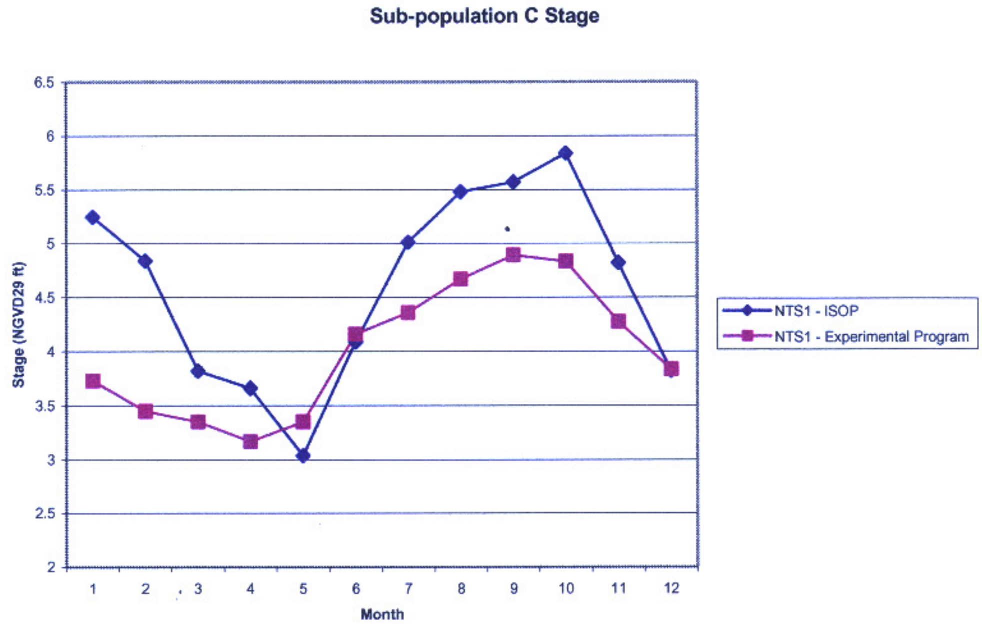


Figure 4.86. Average monthly stage in CSSS sub-population C during Experimental Program and during ISOP, measured at NTS 1.

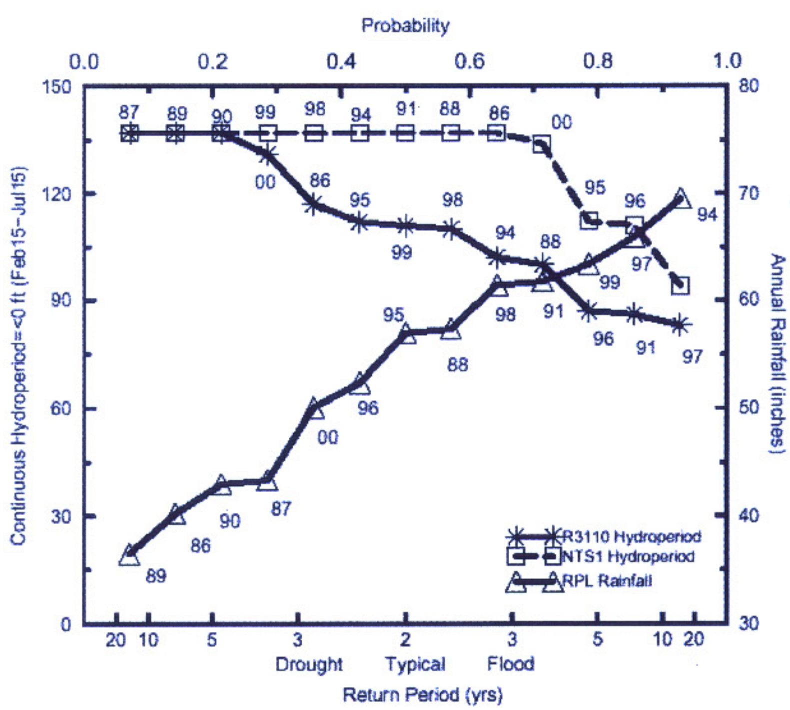


Figure 4.87. Probability distribution for annual rainfall and consecutive days when water table is below the ground surface between Feb. 15 and July 15 at for CSSS sub-population C.

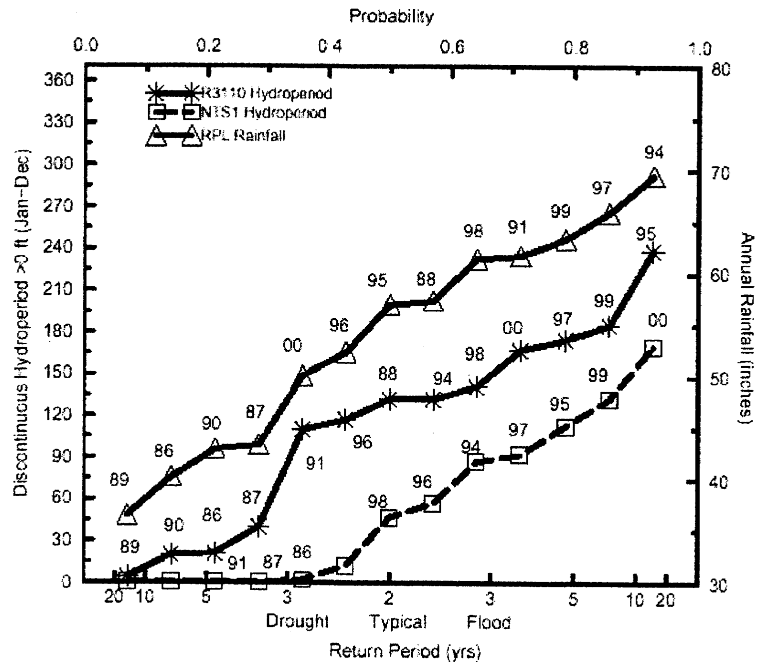


Figure 4.88. Probability distribution for annual rainfall and number of days when water level is over the land surface for CSSS sub-population C.

In sub-population C sustained pumping at S-332 and S-332D through January and early February artificially sustained high water levels that could have limited nesting habitat availability. However, pumping at these structures was dramatically reduced in mid-February. This change in operations, along with below average rainfall, produced steep water level recessions in these habitats resulting in good nesting habitat availability. The percent of habitat availability for sub-population C, as measured by the stage at site E-112 located near the center of this habitat, is shown in **Figure 4.89**. The graph shows that the habitat availability for sub-population C remained over 90% for almost all of the nesting season.

4.5.3.2.4 CSSS Sub-population D (C-111 basin)

Stages in CSSS sub-population D are represented by measurements at Ever4 and Ever7 **(Figure 4.90 and Figure 4.91)**. **Figure 4.91** shows the stage at Ever7 located in the southern extent of sub-population D from March 1st to July 31st. The percent of CSSS habitat available based on the stage at Ever7 shows that between 25% and 60% of the habitat was suitable for nesting. **Figure 4.90** indicates higher than average stages for most months but significantly lower stages during the month of May. At Ever4, the average May stage was lower than the previous years' May average. In general the nesting window is below 45 consecutive days for this location indicating that this site is too wet for CSSS nesting **(Figure 4.90)**. Discontinuous hydroperiods for previous years also show that the habitat for sub-population D does not experience hydroperiods

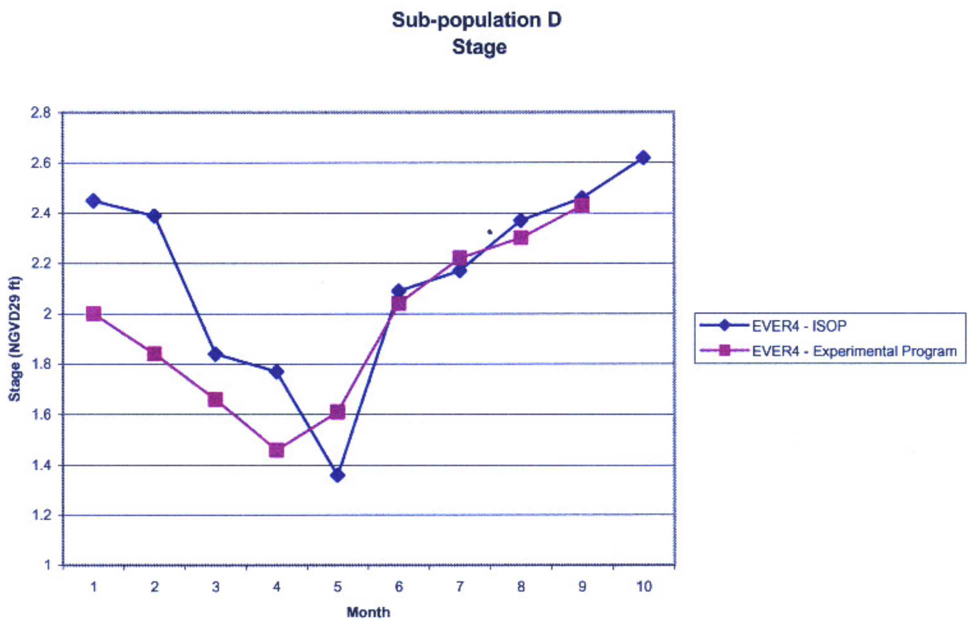


Figure 4.89. Average monthly stage in CSSS sub-population D during Experimental Program and during ISOP.

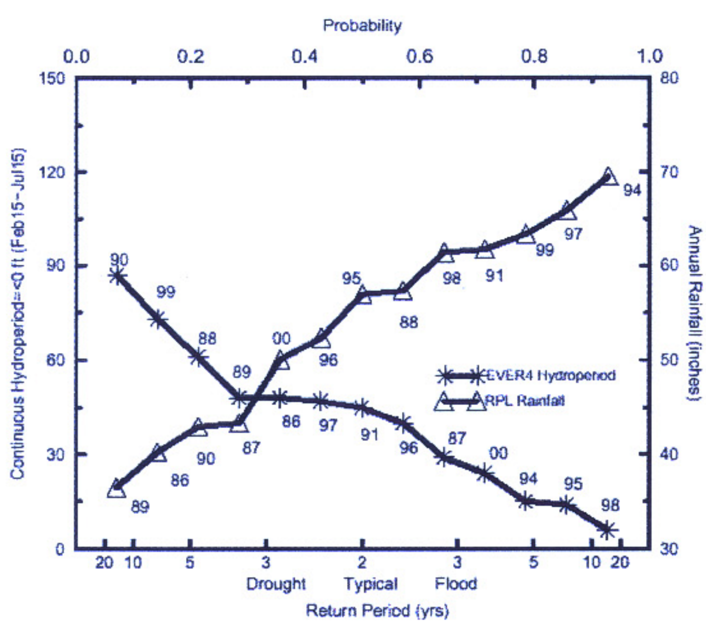


Figure 4.90. Probability distribution for annual rainfall and consecutive days when water table is below the ground surface between Feb. 15 and July 15 at for CSSS sub-population D.

within the 60-180 day window needed to support the appropriate vegetation **(Figure 4.91).** This site could be characterized as too wet for CSSSs before and during the ISOP.

In summary the ISOP did have an effect on the hydrology of sub-population A during 2000. However, earlier closure of S-12A and S-12B might have provided greater benefit, as indicated by the stage recession at NP-205, by increasing the breeding window which was shortened by the April 2000 rainfall event. The ISOP did have a beneficial effect in sub-population C and little or no significant change in sub-populations E and F. From the analysis for sub-population D, determination of the hydrologic effects of ISOP operations on this habitat was not possible. However, sub-population D appears to experience somewhat wetter conditions than what is considered desirable for CSSS habitat.

4.6 Comparison of ISOP and RPA

Figure 4.74 shows the water levels recorded at NP-205 from March 2000 through July 2000. The RPA requirement was for 60 consecutive days of NP-205 water levels below 6.0 feet msl. Water levels exceeded 6.0 feet on April 13, 2000, and did not recede below 6.0 feet until April 26. The onset of the wet season in early June again resulted in water levels exceeding 6.0 feet. Was there anything that could have been done to prevent water levels from exceeding 6.0 feet?

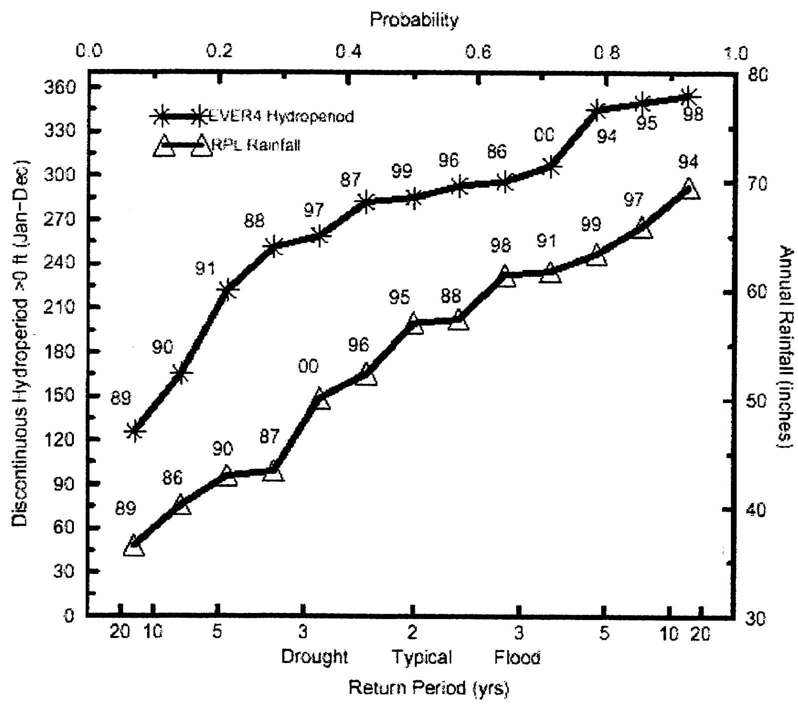


Figure 4.91. Probability distribution for annual rainfall and number of days when water level is over the land surface for CSSS sub-population D.

This is an extremely complicated question, and not straightforward to answer. The Corps of Engineers, in a June 1, 2000 letter to Sam Hamilton stated:

> "We have determined that under **any** [emphasis added] water management scenario (other than the one in which there was a levee encircling sub-population A with sumps operating) including Test 7 Phase II operating conditions, water levels would have exceeded 6.0 feet during this [April, 2000] event."

We performed the following calculations. First, we estimated the rate of change in the recession at NP-205 corresponding to the closure of S-12A. Then, we applied this difference in the rate of recession forward to November 1, 1999, roughly simulating a November 1 closure of S-12A. This difference in recession rate was applied until December 16, 1999 (the actual date of closure), where upon the daily response was assumed to be exactly as observed. The result is shown in **Figure 4.39**. According to this calculation, water level would have peaked below 6.0 feet for the April event.

This calculation has several potential uncertainties. First, estimated recession rates between November 1 and December 16 would tend to be overestimated by this procedure. On the other hand, this analysis does not include the expected increase in recession rates once water levels reach ground surface. Thus, the estimate cannot be considered definitive proof that water levels would have stayed below 6.0 feet if S-12 structures had closed in November, but it does indicate that, a) S-12A closure improved recession rates at NP-205, and b) earlier closure would likely have improved the situation at NP-205.

The RPA called for the Corps to ensure that at least 30 percent of all regulatory water releases (described as the "supplemental regulatory component" in Appendix C of the Final EA for Test 7 (Corps 1997) crossing Tamiami Trail enter ENP east of the L-67 Extension, or provide the hydrologic equivalent of this. **Figure 4.92** shows that the Corps failed to meet the 30% regulatory flow requirements during the period between March 2000 and January 2001. Instead of delivering 30% of the regulatory releases from WCA-3A, operations outlined by the Corps in the March 2000 EA prescribed routing water from WCA-3A via S-151 and S-335, rather than through S-333 (USACE, 2000). As a result, the Corps fails to meet the RPA delivery of 30% of regulatory flow east of L-67 extension **(Figure 4.92)**. In addition, water levels in NESS would be reduced during wet years, due to reduced discharges at S-333, reduced water levels in L-31N below S-331 and decreased stage in WCA-3B.

In addition, the previous analysis indicates that hydroperiods in all sub-populations with the exception of A and C were not increased significantly. By curtailing S-333 discharges when G-3273 rises above the ground surface, there is very little opportunity to improve hydroperiods in sub-population E and in the northern area of sub-population F. Also, by maintaining the S-176 headwater at 4.7 feet there is little opportunity to increase hydroperiods across the Rocky Glades except for within the immediate vicinity of the S-332B detention area where hydroperiods would be increased relative to EWDT71.

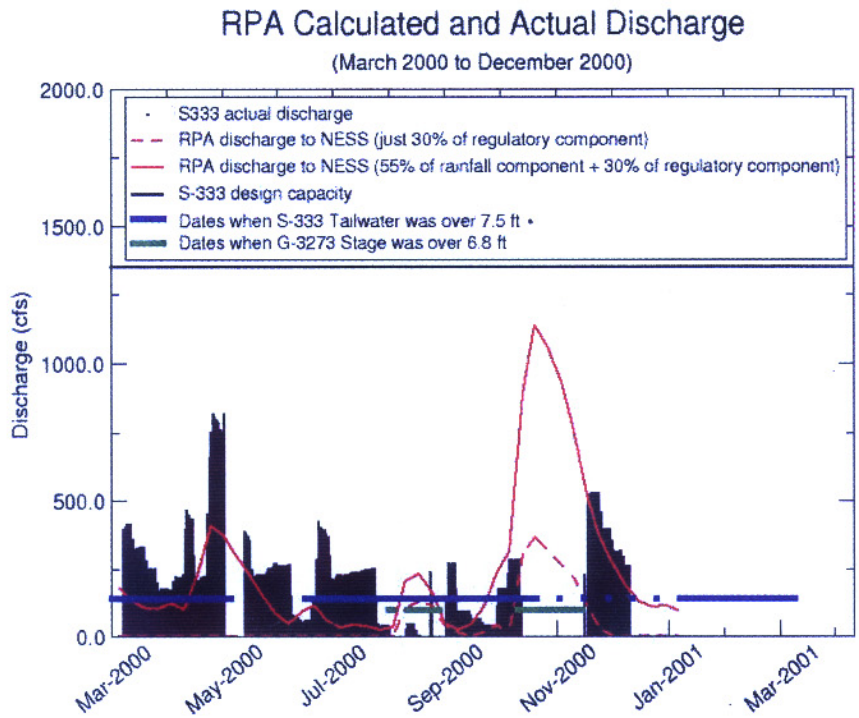


Figure 4.92. S-333 flows and RPA requirements for flows to eastern ENP.

Given the previous uncertainties related to the SFWMM there are only 2 ways to know if the RPA has been met with any certainty. The first is to implement the exact specifications of the RPA, the second is to demonstrate that an alternative action is the hydrologic equivalent of the RPA. The exact requirements of the RPA have not been met for sub-population F and it is not possible to determine if the ISOP provides the hydrologic equivalent of the RPA. It is clear, however that the hydroperiods determined from the available data are significantly less than what is needed and not much different from the hydroperiods at those sights in previous years. It is also clear that water levels in the immediate vicinity of S-332B detention basin are higher when there is water in the detention basin. However, there is a question as to how often there will be water in the detention basin. In 2000 and 2001, S-332B pumping was a wet season operation. Presumably, under Test 7 II operations, higher stages would be sustained through the dry season thereby increasing the hydrologic benefits to NESS.

Perhaps the most important point to make regarding compliance with the RPA is to determine if the intent of the RPA has been followed. In the RPA the FWS clearly states,

> "Implementation of this RPA must be in a way that is consistent with the Experimental Program's intended purpose of improving water deliveries through the Water Conservation Areas south of Alligator Alley and ENP, thereby avoiding adverse impacts to tree islands and other threatened and endangered species and critical habitats. The

> Service believes the best way to achieve this is to make regulatory releases to Northeast Shark River Slough. When the Corps has the choice between two options for implementing this RPA, one which adversely impacts listed species and/or critical habitat, and one which does not, the Corps should choose the option which does not impact listed species or critical habitat."

The does not fullfill this secondary intent of the RPA. By dissecting the RPA into a set of actions for each of the individual CSSS habitats. The Corps has provided a hydrology that is a poor substitute for the natural system that the endangered species and critical habitats of the Everglades require. Drainage of NESS and WCA-3B, in this manner, could cause adverse impacts to the Wood Stork colony south of Tamiami trail as well as threaten the tree islands in WCA-3B by subjecting them to increased fire risk.

Placing pumps and structures on the edges of CSSS habitats subjects the sub-populations to frequent changes in hydrology related to water management strategies based on flood control criteria rather than habitat criteria. The previously described President's Day fish kill is an example of an unintended consequence of such water management. Nott et al. (1998) demonstrate that the CSSS requires a habitat that consistently provides appropriate nesting conditions and vegetation. Water management in the Everglades can best provide these conditions by reducing drainage of the natural areas and restoring the natural flow paths. The RPA moves closer to that goal by raising water levels in the L-31N and C-111 canals and returning the natural flows to NESS. The ISOP moves further away from that goal by routing water away from NESS and short-circuiting the natural flow path.

4.7 Other Ecological Effects of the ISOP

4.7.1 Fish and Aquatic Invertebrates

Ramping rates (rates of increasing and decreasing managed flows)

Adverse effects to aquatic communities were observed in Taylor Slough and the Rocky Glades under the ISOP. Lower canal stages in L-31N after the sudden shutdown of pumping to dry out the eastern CSSS nesting areas, rapidly increased the rates of recession in the Rocky Glades and precipitated a very rapid loss of surface water. About one week after the rapid drawdown, evidence of stranding was investigated by ENP staff in the marsh west of L-31W and north and south of pump 332. Stranded fish and invertebrates were observed, photographed, and collected on February 23-24, 2000. It is necessary to observe stranding very soon after it occurs, because decomposition rates are rapid in subtropical areas. Organisms that were observed and marked on February 23 were already quite decomposed by the next day. Much additional stranding of fish and invertebrates appeared to have occurred in the week before and after the sample period. The area sampled was small in relation to the extent of the stranding event. Large flocks of vultures were observed throughout the area west of L-31W for several weeks, and the smell of decomposition was very evident along the Main Park Rd. on the eastern side of ENP.

Sampling was impromptu, because notification of the rapid shutdown of pumping was not adequate to design a more through study of the effects on aquatic organisms. Fish and invertebrates were sampled in seven 1-square-meter areas where stranding was observed west of L-31W in the area of pump 332. Mean densities in the 7 samples were 183 fish, 26 freshwater prawns, 4 crayfish, and 27 snails (including apple snails) per square meter. Other aquatic invertebrates in the orders, *Amphipoda, Isopoda, Coleoptera, Diptera, Ephemeroptera,* and *Odonata* were collected, but preservation of these more fragile organisms was not good enough to get accurate counts. It is presumed that most of the fish and invertebrates were stranded and died because of the fast rate of drawdown of marsh surface water. Fish and aquatic invertebrates appeared to be stranded over several square miles, resulting in large-scale mortality of aquatic animals. These impacts likely occurred elsewhere in Taylor Slough as well. The effects were magnified because discharge was relatively stable and depths were high during the period from December through early February.

Aquatic organisms in the Everglades are adapted to surviving under slow, natural recession rates, so it is important to mimic natural recession rates when changing inflows and pumping schedules. It is very important to ramp down (slowly decrease discharges) when discharge at a pump is reduced, especially after water levels have been high, as they had been for several months before this stranding event. Discharge should be slowly reduced over a period of about a week to allow aquatic organisms to move to areas that are still wetted on the surface or to deeper solution holes and alligator holes where they are available. Some species of fish and invertebrates will move with the retreating water. Some aquatic invertebrates can burrow (crayfish) or enter resting stages (copepods and some aquatic insects) if the drawdown rate is slow enough to elicit the appropriate physiological changes and behavioral responses. Also, a slower rate of drawdown is important to prevent temperature or chemical (dissolved oxygen) shock to the aquatic organisms. Natural recession rates should be mimicked to allow for a more natural transition to the dry season. Organisms of the marl prairies in the Rocky Glades experienced a dry period during a few months under natural conditions, and a number of organisms have adaptations that allow them to survive if the timing and rate of drydowns are similar to natural drydowns. It is also very important to minimize flow reversals and repeated drydown events, because every drydown kills a greater percentage of the population and leaves fewer organisms to recolonize the marshes during the next wet season. Lower population densities reduce the possibility that populations of aquatic organisms will recover enough to provide an adequate forage base for alligators, wading birds, and endangered species, such as the CSSS and snail kite.

General Comments

Aquatic organisms require continuous hydroperiods at depths of at least 0.5 feet above ground surface (1 feet for large-bodied fish species such as largemouth bass), except for short drydown periods during droughts, which serve to maintain the marsh habits in the variable environment of the Everglades. Shorter-hydroperiod marshes (e.g. marl prairies on the edges of Shark Slough and in the Rocky Glades) can serve as aquatic habitats if there are a large number of below-ground refuges (alligator holes in Shark Slough; solution holes in the karstic landscape of the Rocky Glades), if below-ground water levels are maintained above -1 feet during the dry season, and if dry periods last only for a few months. The IOP alternatives do not generally provide for any restoration of aquatic organisms by increasing hydroperiods or reducing the number or duration of drydowns. The alternatives were generally much worse than NSM and in some cases are worse than 1995 base conditions for aquatic animals.

Evaluations of aquatic organisms were based on a comparison of the alternatives to the 1995 base conditions (EWDT71), and NSM conditions were used as the goal with regard to the direction of change desired when evaluating each performance measure. Evaluations were made for fish and aquatic invertebrates as one entity, with consideration given to general conditions that would favor aquatic animals. However, there is a risk of overgeneralization given that there are many aquatic animal species, and responses of any individual aquatic organism may differ from the generalizations. Most organisms respond positively when hydroperiods are increased. For example, recent studies on the marl prairie species in ENP have shown increased densities, survival, and growth of crayfish with increasing hydroperiods; the optimal period of flooding for this species matched the predrainage hydroperiods for marl prairies. Evaluations of long-term marsh fish data have shown that fish densities, biomass, and species richness are generally higher when hydroperiods are longer and that it can take years for fish communities to recover following long drydowns.

Some general concerns about aquatic organisms under the ISOP relate to the delayed re-wetting of marshes as a result of keeping CSSS areas dry until completion of nesting. Delayed flooding could have serious consequences for aquatic populations and organisms that have just come through a stressful period during the dry season with high mortality or reduced body condition. This cannot be evaluated by looking at average conditions over the long-term period of record (i. e. looking at model output). Also, when inflows are kept lower than they would be based on rainfall, there is a greater chance of having flow reversals, which lead to increased mortality of aquatic organisms.

General concerns about switching to a new operational plan relate to the fact that when changes are made abruptly, rather than gradually over time, organisms and habitats do not have time to adjust to the changes, and unexpected results may occur. For example, even with much wetter conditions in eastern areas of the Everglades, many organisms that currently occur in these areas disappear following a sudden change of operations. Achieving a new equilibrium in community productivity may not occur if operations are changed repeatedly. Many aquatic organisms that currently occur in the Rocky Glades, for example, are semi-aquatic, and are adapted to surviving longer periods of drydowns through drought-survival mechanisms, or move into the area only during flooding. Thus the current high diversity of aquatic invertebrates in the Rocky Glades may be reduced by the new operational plans.

4.7.2 Wading Birds

In 2000, the estimated number of wading bird nests in south Florida was 39,480 (excluding Cattle Egrets), a 40% increase over 1999 which was one of the best years in a decade. The increased nesting effort in 2000 was attributable to White Ibises, Wood Storks, and Snowy Egrets, all of which have markedly declined in the past decades. The 2000 nesting year was the best since the

1970s for Wood Storks and since the 1940s for White Ibises. However the number of nests of most other species declined relative to 1999.

The overall increase in the number of nests was primarily due to increases in WCA-3 with smaller increases in ENP and Florida Bay and a 75% decrease in Loxahatchee National Wildlife Refuge. Systematic Reconnaissance Flights surveys show that bird numbers were high in the WCAs prior to the nesting season indicating that more birds are arriving in the early dry season than have in the recent past.

An hypothesis offered to explain the increases in 2000 suggests that droughts in the southeastern U.S. drove more birds into the Everglades prior to the nesting season and that wet conditions at the start of the dry season followed by a rapid, prolonged drawdown optimized prey densities. However, this hypothesis can be neither accepted or rejected based on existing information.

In ENP, there was a 63% increase in the number of nests in mainland colonies in 2000 compared to 1999, and four times that of 1998. The most abundant nesters were Wood Stork (1592 nests) and Great Egret (1110 nests), but only 20 White Ibis nests were seen, all at Tamiami West. Only the generalist Great Egret was well distributed in ENP, building nests at 11 of the 12 mainland rookeries, including 30 pairs at the East River colony, the first occupancy in 6 years. In contrast, 85% of the Wood Stork nests were found at Tamiami West. Overall nesting effort in ENP remains depressed. However, because the assessment was made aerially, the number of most of the small herons and egrets could not be accurately determined. The recession rates and water levels recorded at the P-33 monitoring station resembled those of the very wet 1995-96 year, helping to explain the overall low numbers of birds. At that time, as in other wet years. wading birds were dispersed across the park in low densities and numbers. In 1996, surface water remained over most of the park, a condition inimical to wading bird foraging and therefore nesting success. In contrast, in a year favorable to wading birds, such as 1985, birds concentrate in the shallow wetlands found in the transitional area between wet and dry surface water, where they take advantage of the concentrated prey base.

Nesting activity has been observed since 1995 in Florida Bay. Great White Heron nesting was higher than the last two years, estimated at 269 nests in February 2000, although this figure was lower than in the first two years. Nesting by White Ibis and Roseate Spoonbills also increased this year, with 500 nests of the former and 100 of the latter observed. However J. Lorenz (National Audubon Society) noted that the first nesting attempt of the Spoonbills failed at Tern Key, probably a response to high water levels in mainland wetlands. Water management operations that route more flows into the lower C-111 would be expected to reduce spoonbill foraging and nesting success and adversely affect other short-legged wading birds.

4.7.3 Snail Kites

Preliminary results, as of April 29, 2000, provided by researcher Vicky Dreitz are as follows: NESS, 2 nests; Shark Valley, 8 nests; St. Johns Marsh, 5 nests; West Lake Toho, 5 nests; WCA-3A, 94 nests; and WCA-3B, 26 nests. Areas in which no nests have been found include Lake

Kissimmee, East Lake Toho, Lake Okeechobee, ARM Loxahatchee National Wildlife Refuge, West Palm Beach Water Catchment Area, WCA-2A, WCA-2B, and Big Cypress National Preserve.

The majority of nesting snail kites in WCA-3A are concentrated along the cypress edge of the western side. The kites in WCA-3B are mostly along the southern edge north of Tamiami Trail. Drietz noted that during the survey of Shark Slough an estimated 50-80 birds were seen. However, access to a significant number of snail kites seen off the main airboat trail in Shark Slough was limited so nesting effort probably remains underestimated. Drietz had no explanation for this year's distribution of snail kites in south Florida, other than to say that apple snails are obviously doing well in these areas. Drietz indicated such an investigation would likely be a topic of a future report.

4.7.4 Alligators

Like wading birds, alligators rely on the steady dry season recession of water levels and the resultant concentration of food items to maintain a healthy body condition. This dry season concentration of prey in holes carries the alligator through the thermoregulatory stress of the dry season, prepares them for the upcoming breeding season, and sustains them through the next wet season when food is dispersed and more difficult to find. The effects of an "extended" wet season were documented in ENP during the high water years of 1994-95 when prey remained dispersed and alligator body condition declined.

If, as a result of an exceptionally rapid recession of water levels, fish and other aquatic organisms do not move to refugia yet remain dispersed and stranded, alligator body condition suffers. Alligators in such a situation are stressed in multiple ways by having to expend energy to maintain a hole, maintain body condition, and actively thermoregulate, with little or no food. Alligators are probably more impacted by cumulative impacts over several years. It would probably be difficult to see the effects in only one year of a particular water management practice. However the conditions of the past year are unlikely to have been favorable for alligators in most areas of ENP. Water management practices that repeatedly stress alligators beyond their natural tolerances will probably result in a decline in their ability to persist and, at some point, this would reduce reproduction (e.g. clutch size and hatching success (Ken Rice, pers. comm.)). Results from surveys of alligator body condition in eastern areas of ENP will provide further information.

4.7.5 Tree Islands

The response of freshwater marsh vegetation, including tree islands, is governed to a great extent by water depths and flooding durations. Thus the deeper inundation during wet periods in WCA-2A such as in the past year is likely to have been detrimental to the few remaining tree islands. In southern WCA-3A, however, where many more tree islands occur, flooding depths in the past year were slightly lower than in other recent years. No effects upon tree islands in ENP were observed as a result of hydrological conditions of the past year. Consequently, flooding stress to tree islands can be assumed to be reduced to a small extent under the ISOP 2000, although no data are available. Because of the far greater number of tree islands in WCA-3A than in WCA-2A, the net effect is interpretable as an alleviation of tree island impacts attributable to high waters.

4.7.6 Other Vegetation

The prolonged flooding by deep water typifying the pooled areas of WCA-2 and WCA-3 produce conditions unfavorable for emergent species like sawgrass and its associates while favoring slough vegetation and, particularly where nutrients inputs are enhanced, cattails. To the extent that recent hydrologic conditions represented a departure from the deeper flooding in southern WCA-3A as seen in EWDT71, a small benefit may have accrued. However, the absence of a flow component to the deep water conditions (in conjunction with the closely related phenomenon of compartmentalization), is a major departure from natural conditions, and may have adverse effects upon vegetation development and persistence by limiting distribution of propagules and nutrients, and by affecting water column chemistry, and therefore, growing conditions. These effects have been demonstrated in ecosystems outside the Everglades where fluvial processes are important. In any case, improvements in hydrological condition relative to marsh vegetation would have to be expressed over at least several years before measurable changes could be detected, so benefits that may have accrued recently are conceptually, rather than empirically, based.

In the marl prairies on the western flanks of Shark Slough, the lowered water levels in the dry season that benefit the CSSS also would relieve some of the out-of-season flooding stress on vegetation that has occurred there recently, helping to provide conditions more favorable for this community. However, as is generally true for perennial vegetation, several years of improved conditions may be needed to cause a meaningful change in the plant community. In so doing, species diversity is likely to be increased because the drier marl prairie communities tend to be more diverse than the wetter sawgrass communities. In contrast, however, shorter hydroperiods also occur in NESS. These are clearly detrimental to the aquatic plant and animal communities that must have prolonged slough hydrological conditions to sustain productivity, Instead the ISOP conditions have been inimical to re-establishment and persistence of peat-forming *Nymphaea*-dominated aquatic slough vegetation. Instead evidence suggests that there will be continuation or expansion of sawgrass-dominated communities in association with little or no peat accretion.

4.7.7 Aquatic Vegetation in Lower Taylor Slough and Panhandle Region

The decisions made to redirect flows in the Everglades can be expected to have consequences for the estuaries. Results of current studies on the impacts of the ISOP on submerged aquatic vegetation in the mangrove zone creek systems associated with the foraging areas of spoonbills (e.g. in southern Taylor Slough and the lower C-111 basin) are not yet available for year 2000. But preliminary results from 1996-1999 coincide with the earlier findings in indicating that large, rapid fluctuations in salinity adversely affect submerged aquatic vegetation within the ecotone near northeastern Florida Bay (Lorenz 1999). These rapid changes inhibit successional changes in community composition, often leading to complete vegetation die-off which leave an unstable bay bottom. Earlier research has shown that barren bay-bottom areas are susceptible to wind events that can lead to turbid water conditions that further hinder the reestablishment of submerged aquatic vegetation communities. Unvegetated areas also have a negative impact on the epifauna and benthic invertebrates at these sites, thereby decreasing the quantity and quality of food for fish foraging. Studies have shown that vegetated areas provide shelter for small fishes and have a higher abundance of invertebrate fauna than unvegetated areas. Therefore, Lorenz et al. (1999) concludes, the fishes in unvegetated areas lack optimal foraging conditions due to lack of available prey which could lead to lower productivity, thereby explaining the reported inverse relationship between salinity and fish biomass.

4.7.8 Summary

In summary, observations of ISOP operations suggest that wading bird populations in WCA-3A will improve, while those in ENP will remain stable or decrease. Adverse impacts of several kinds are expected primarily in the Rocky Glades, Taylor Slough and lower C-111. These include loss of aquatic animal communities, decreased wading bird foraging habit, and adverse effects on vegetation and alligator populations if hydrological conditions are continued for the long-term.

4.8 Water Quality Results of ISOP operations

The two main flowways into ENP are Shark Slough and the Taylor Slough/Coastal Basin. Shark Slough inflows have been measured at the S-12 structures and S-333. Historically, the inflow points for Taylor Slough have been the S-175 and S-332 structures; however, these two structures have been replaced with S-332D. Flows for the Coastal Basin are represented by the S-18C discharges which receives discharges from the C-111 and C-111E canals. The C-111 is mostly marsh seepage water from ENP that is characterized by very low phosphorus concentrations (Walker 1997). C-111E canal water (as represented by S-178) has the highest mean phosphorus concentration of any structure in the C-111 Basin (FDEP 1996). In the past, at S-18C, the good quality water from the S-111 canal diluted the poor quality water from the S-111E canal. However, in the future the S-332D pump will pump the seepage water in the C-111 back into Taylor Slough. This will reduce the dilution effect at S-18C, increasing the phosphorus levels at this structure.

As a requirement of the S-332B pump test and the temporary operation of S-332D, the Corps extensively sample in the northern C-111 Basin. They installed time activated automatic surface water samplers; one in L-31N south of S-331 and another upstream of S-332D. The automatic samplers collect discrete samples usually every 8 hours for total phosphorus analysis. An analysis of these data will characterize L-31N total phosphorus levels of surface water that will be pumped into ENP by S-332B and S-332D.

The Corps has reported total phosphorus concentrations at various intervals, from 1 per 30 minutes (S-332D pump test on August 1999) to every other day (early September 1999) for S-331 downstream and S-332D upstream. Raw data from August through November 1999, January

2000 and March 2000 were summarized monthly for easier analysis. On days when multiple samples were taken, a mean value was calculated. If the total phosphorus concentration was below the minimum detection limit, then the concentration used in the calculation was one-half of the minimum detection limit. One value was deleted (at S-331, September 22, 1999) from the analysis because it was an obvious outlier. **Figure 4.93** is a representation of these data. Most of the monthly mean total phosphorus concentrations are above the 10 ppb default value for the Everglades total phosphorus threshold criterion from Florida's Everglades Forever Act. Samples from downstream of S-331 had slightly higher concentrations than upstream of S-332D. There also appears to be some seasonal (wet season/dry season) effect.

The Corps collected groundwater samples around the S-332B pump station and retention area in late March and early April 2000 before S-332B start up. Four samples were collected at RET-ND, RET-NS, RET-SW and RET-SE and three samples at the other stations. Mean total phosphorus concentrations were computed for each station and plotted **(Figure 4.94)**. At each site the mean total phosphorus concentrations were above 100 ppb.

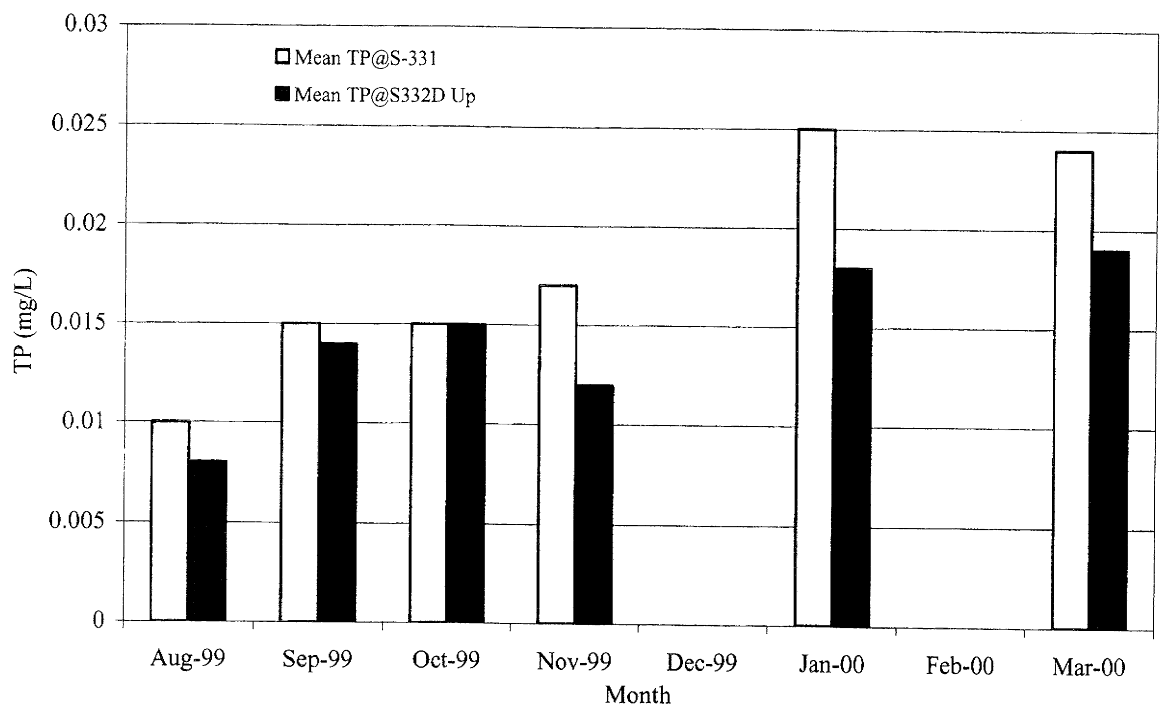


Figure 4.93. Monthly mean total phosphorus concentrations.

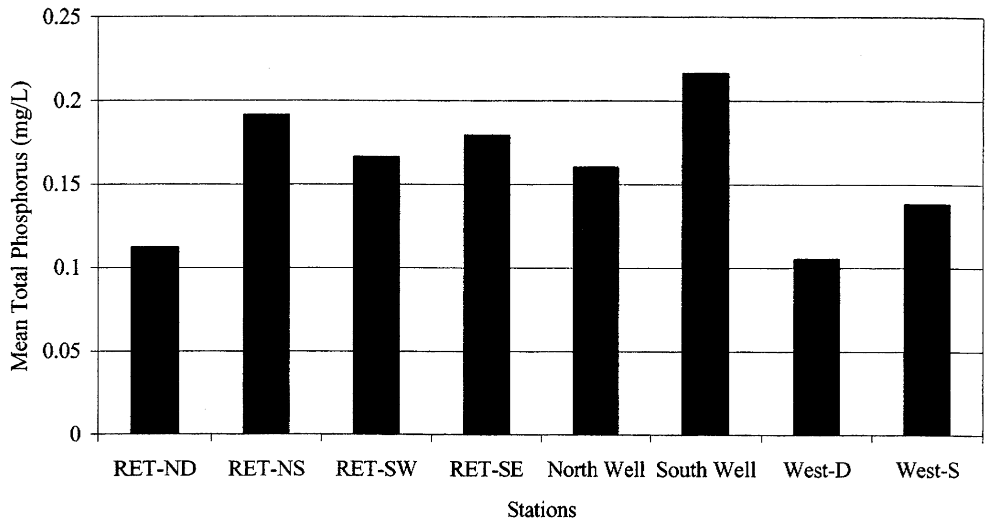


Figure 4.94. Mean total phosphorus in groundwater at S-332B

Literature Cited

FDEP 1996 Draft report. A Preliminary Evaluation of Water Quality in the C-111 Canal Basin.

Haitjema, H.M. 1995. Analytic Element Modeling of Groundwater Flow. Academic Press. San Diego, CA.

Johnson and Vanlent et al. 1993. Water management in Taylor Slough and effects on Florida Bay. Technical Report SRFC 93-03. Everglades National Park, Homestead, FL

Karl, T. R., C. N. Williams, Jr., and P.J. Young, National Climatic Data Center, and W. M. Wendland, Illinois State Water Survey, Journal of Climate and Applied Meteorology, January 1986, American Meteorological Society, Boston, MA.

Knight et al. 2001. The Status of the Hydrologic Conditions in Everglades National Park, June 1999 to May 2000. Tech. Report SFNRC 2001-01, Everglades National Park, Homestead, FL

Lorenz , J. et al., 1999. Nesting Patterns of Roseate Spoonbills in Florida Bay 1950-1999: Implications of Landscape Scale Anthropogenic Impacts. Abstract: 1999 Florida Bay and Adjacent Marine Systems Science Conference, Key Largo, FL.

MacVicar et al., 1984. South Florida Water Management Model Documentation Report. Technicial Pub. 83-4, Resources Planning Department, South Florida Water Management Districy, West Palm Beach, FL

Mitchell-Bruker, S. and H. M. Haitjema. 1996. Modeling steady state conjunctive groundwater and surface water flow with analytic elements. Water Resourc. Res. V32, no.9.

Nott, M.P., O.L. Bass Jr., D.M. Fleming , S.E. Killeffer, N. Frahley, L. Manne, J. L. Curnutt, T.M. Brooks, R. Powell, and S.L. Pimm. 1998. Water levels, rapid vegetation changes, and the endangered Cape Sable seaside sparrow. Animal Conservation. 1(1):23-32.

South Florida Water Management District, 1997. Draft documentation for the South Florida Water Management District, Hydrologic Systems Modeling Division, Planning Department, West Palm Beach, FL

Strack, O.D.L. 1981, Flow in aquifers with clay lamina. I. The comprehensive potential. Water Resourc. Res. 17:993-1004.

Townley, L.R. 1995. The response of aquifers to periodic forcing. Advances in Water Resources 18:125-146.

U.S. Army Corps of Engineers, 1953. U.S. Army Corps of Engineers, 1953, Part I: Agricultural and conservation areas supplement 7-design memorandum permeability investigations by well pumping test: Partial definite project report, Central and Southern Florida Project for flood control and other purposes, 27.;app:A-1 to D-44 86 pls.

U.S. Army Corps of Engineers, 1997. Environmental Assessment and Finding of No Significant Impact: Test Iteration 7 of the Experimental Water Deliveries to Everglades National Park. U.S. Army Corps of Engineers, Jacksonville District, Jacksonville, FL

U.S. Army Corps of Engineers, 2000. General Reevaluation Report and Supplemental Environmental Impact Statement Modified Water Deliveries to Everglades National Park, 8.5 Square Mile Area, Appendix A. Department of the Army, Jacksonville, District, Corps of Engineers. Jacksonville, Florida.

U.S. Army Corps of Engineers, 2001. U.S. Army Corps of Engineers, Draft Environmental Impact Statement Interim Operational Plan (IOP) For Protection of the Cape Sable Seaside Sparrow, Jacksonville District, Jacksonville, FL

Walker, William W., Jr. 1997. Draft report for USDOI/ ENP. Analysis of Water Quality & Hydrologic Data from the C-111 Basin.

Chapter 5- Federally Listed Threatened and Endangered Species Evaluations

5.1 Cape Sable Seaside Sparrow

5.1.1 Overview

As explained in the Executive Summary, full analysis of IOP Alternatives was limited to Phase 1 of Alternatives 1, 5 and 6. Since we cannot predict the exact future rainfall patterns that will occur during IOP implementation, we must base our predictions of the hydrological and biological effects of IOP alternatives on past experience. Expected hydrological effects can be predicted on a coarse scale by simulating the alternatives with the SFWMM using a series of 31 years of past rainfall records. The results predict the hydrological conditions that would have occurred if the different alternatives had been in place during those past years. Hydrologic experts agree that the 31 years of rainfall data used are the best representation of natural rainfall variability in the modeled area that is currently available, and that modeling results using the record provide a reasonable prediction of the range of hydrological conditions we would see in future years. However, as explained in Chapter 4, SFWMM results are averaged over 4 or more square miles. Therefore, use of the SFWMM results is appropriate in areas where biological analysis can be based on large scale hydrologic averages. Where smaller scale effects are biologically relevant, and/or where SFWMM results are subject to a large degree of error due to model limitations, exclusive use of the SFWMM results is not appropriate. In these cases, we turn to analysis of actual data collected during similar water management operations, and other methods of hydrologic analysis to provide the basis for our biological analysis.

For the CSSS's A and B sub-populations, SFWMM results are used here because hydrologic experts agree that these areas are well represented in the model and we have no reason to expect that biologically significant effects missed by averaging the results over large areas would change our conclusions. For the CSSS C, D, E and F sub-populations, hydrologic experts have advised that other methods of analysis may be more appropriate because of the small size and proximity to canals, levees and control structures of these habitat areas and the effect this has on the model results. In particular, modeling experts have concluded that the S-332B pump and retention area are poorly represented in the SFWMM, likely causing the model to predict much greater effects from S-332B in areas including the sub-population E and F habitats than would be expected during real operations, and hiding biologically significant small-scale differences in hydroperiods and overflow occurrence at the S-332B retention area. Chapters 4 presents a detailed discussion of this issue and provides three alternative methods for predicting IOP effects in the sub- population E and F habitats. Two of these alternative methods are based on data from actual operations of the S-332B pump. The third method is based on a different hydrological model that modeling experts from the Corps, SFWMD and NPS agree can provide a more accurate representation of S-332B and the sub-population E and F habitat areas than does the SFWMM modeling. Additionally, as described in Chapter 4, SFWMM of the S-335 structure does not represent the way the structure is actually operated, so interpretation of the SFWMM results should take this into account.

Based on the available hydrologic information and advice summarized above, the FWS has conducted the following analysis of the effects of IOP alternatives on CSSS sub-populations A, B, and C using the SFWMM results. For sub-populations D, E and F, the SFWMM results are reviewed, but our final determinations include consideration of the more reliable results detailed in Chapter 4.

One important hydrologic measure of the potential for CSSS nesting success is to determine the number of consecutive days during the CSSS's breeding season (defined for this analysis as between March 1 and July 15) that water levels are below ground surface. This is an indirect measure of the number of days potentially available for CSSS courtship and nesting, based on biological research that has shown that the CSSS behaviors indicative of reproductive activity are greatly reduced when water levels in their habitats are more than a few centimeters above the ground (Lockwood et al. 1997). **Figures 5.1-5.6** are plots showing the frequency of consecutive days when water levels are below ground in the period between March 1 and July 15 as predicted by the SFWMM.

Interpretation of these graphs is based on the best available biological information on the CSSS and the sustainability of the various sub-populations. Discussions with CSSS researchers in 1998 led to the following general interpretations: alternatives that provide 40 consecutive days for 8 out of 10 years are considered favorable for CSSS sub-population persistence; 40 days for 7 out of 10 years is considered borderline for persistence, 80 days for 7 out of 10 years is favorable, and 80 consecutive days for 8 out of 10 years is considered very favorable (S. Pimm, pers. comm., 1998). A formal AOU peer review of biological information on the CSSS conducted in 1999 provided additional, peer reviewed, and more specific recommendations for sub-population A (Walters et al. 1999). Additional recommendations were also given for the eastern CSSS sub-populations, including sub-population E. Because these latest recommendations are the product of a formal peer review, FWS has concluded that they represent the best currently available scientific information on the hydrologic conditions necessary to prevent the extirpation of these sub-populations and the extinction of the CSSS population as a whole. These recommendations are provided in detail in Chapter 3 and those most pertinent to our analysis are repeated here:

> We conclude that under the current water management strategy, near-term extinction of sub-populations A and D are realistic possibilities. We further believe that retaining water in WCA-3A rather than releasing it west of Shark Slough and into Taylor Slough in wet years will substantially reduce the risk of extinction of sub-populations A and D.
>
> ....releases of water west of Shark Slough should be regulated to avoid extirpation of sub-population A. Specifically, the population should recover to some reasonable level, perhaps 1000 birds, before releases that will inhibit reproduction are allowed. After the population is recovered, releases could be allowed in wet years, but only periodically and not in consecutive years."

> Specifically, we recommend that water be managed to enable high productivity until sub-population A has recovered to at least 1000 breeding birds. A dry period of 50-60 days, beginning 15 March, is the minimum required to ensure reasonable productivity, and a period of 80 days is preferable. A dry period of 50-60 days should allow most females to complete one brood, and a few to complete two, whereas an 80-day dry period should allow most females to complete two broods.
>
> The best alternative is to reduce flows west of Shark Slough and into Taylor Slough, and increase flows into NESS to the extent possible using existing structures. This alternative would benefit sub-populations D, E and F, as well as A.
>
> The best available means to reduce the risk of extinction of the CSSS is to retain and recover sub-population A. Sub-population E should be monitored carefully while interim water management remains in place, because the persistence of this population also is important to the future of the CSSS. However, more aggressive management of sub-population E should be designed and implemented should monitoring indicate substantial declines in that population. The risk of extinction of the total population obviously is increased by the reduction of the number of large populations from three to two.

Since the current estimate for number of CSSSs in sub-population A is only 128, down from 400 in 2000, FWS concludes that the specific recommendations for number of consecutive days of dry conditions provided by the AOU panel should continue to guide our analysis of IOP alternatives for sub-population A. Since the estimate for number of CSSSs in sub-population E was 912 when the peer review report was written and the current estimate of 848 does not represent a significant change in sub-population E numbers (the difference is within the error range of the sampling technique), FWS concludes that the RPA requirements designed to reduce fire risk for the sub-population E habitat are sufficient and that more aggressive management need not be designed and implemented at this time.

Another method for interpreting the SFWMM results for sub-population A is comparing the predicted number of consecutive days below 6.0 feet at the hydrologic gage NP-205 between March 1 and July 15 to the RPA requirement of at least 60 days using this measure. We note that this method is consistent with the AOU panel recommendations. **Figures 5.7** provides this information.

The hydrologic regime required to maintain the CSSS`s wet prairie habitat is also an important factor in evaluating water management alternatives. **Figures 5.8 through 5.13** are measures of the number of days per year that one can expect the CSSS habitats to be flooded as predicted by the SFWMM. For the purposes of this evaluation, a 0-2 month average hydroperiod is not expected to support vegetation favorable to CSSS nesting, a 2-4 month hydroperiod is considered favorable and supportive of *Muhlenbergia capillaris* dominated habitat suitable for CSSS nesting, a 4-6 month hydroperiod is considered good for other vegetation favorable to CSSS nesting, and a hydroperiod greater than 6 months is not expected to support vegetation favorable to CSSS

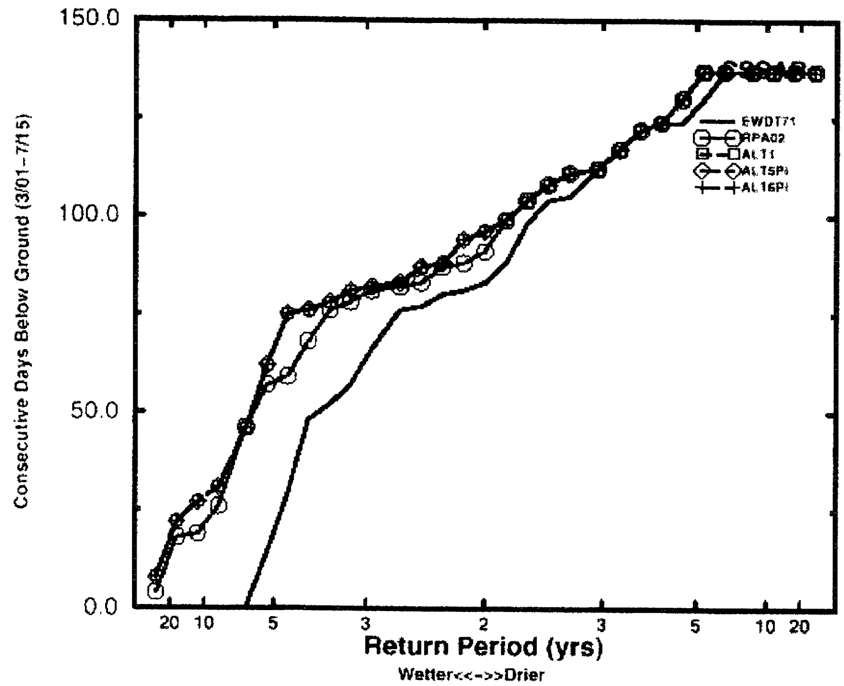


Figure 5.1. Continuous duration water level below ground surface from March 1 to July 15 for CSSS sub-population A.

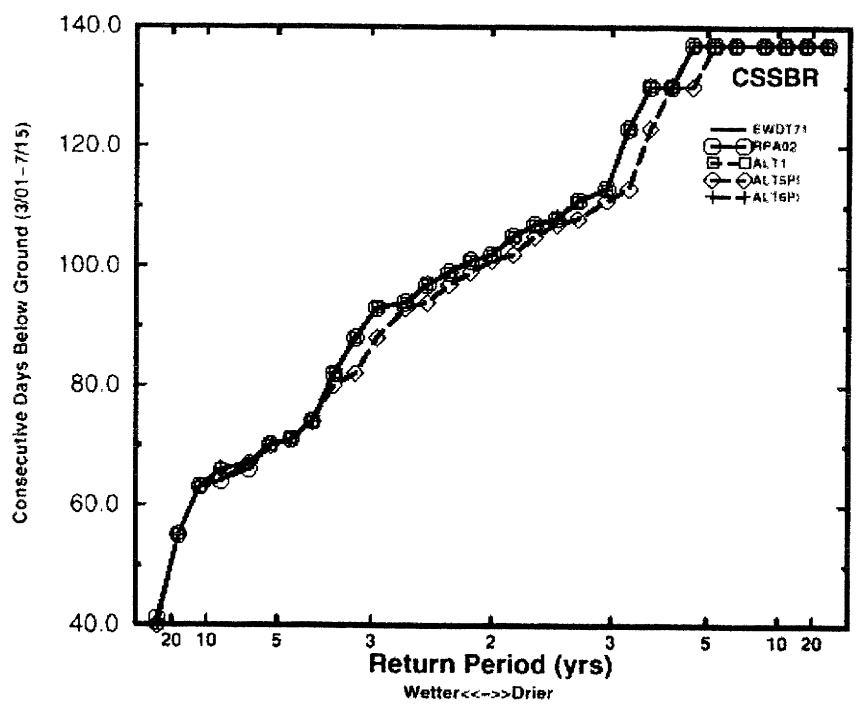


Figure 5.2. Continuous duration water level below ground surface from March 1 to July 15 for CSSS sub-population B.

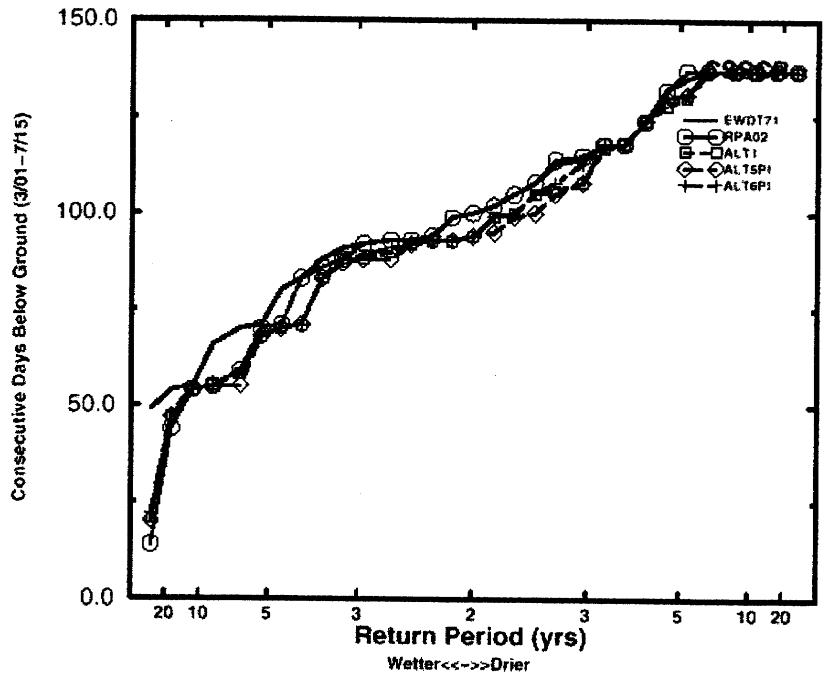


Figure 5.3. Continuous duration water level below ground surface from March 1 to July 15 for CSSS sub-population C.

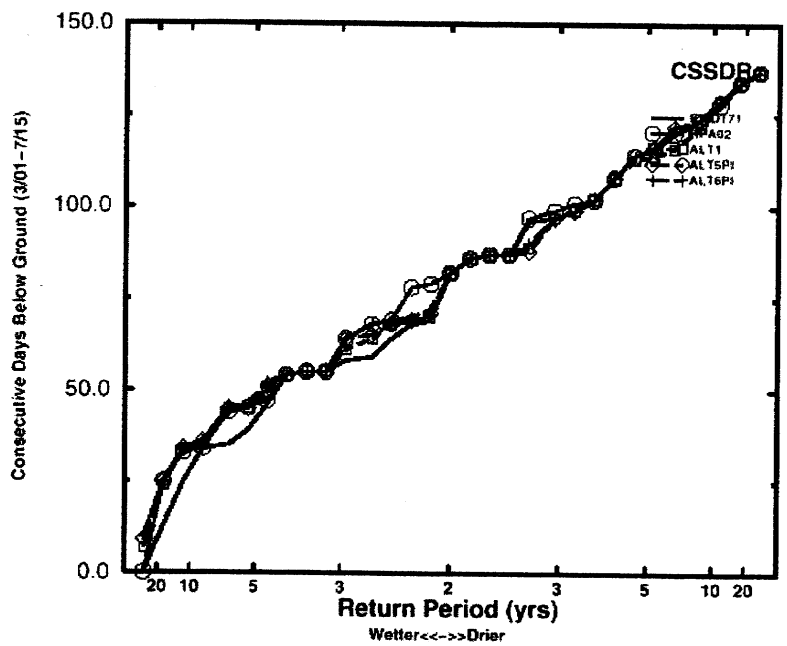


Figure 5.4. Continuous duration water level below ground surface from March 1 to July 15 for CSSS sub-population D.

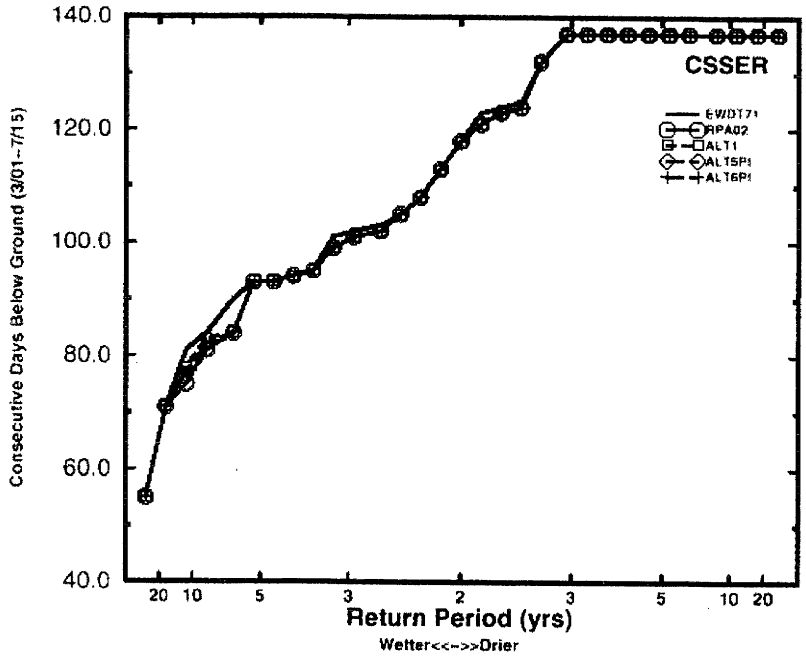


Figure 5.5. Continuous duration water level below ground surface from March 1 to July 15 for CSSS sub-population E.

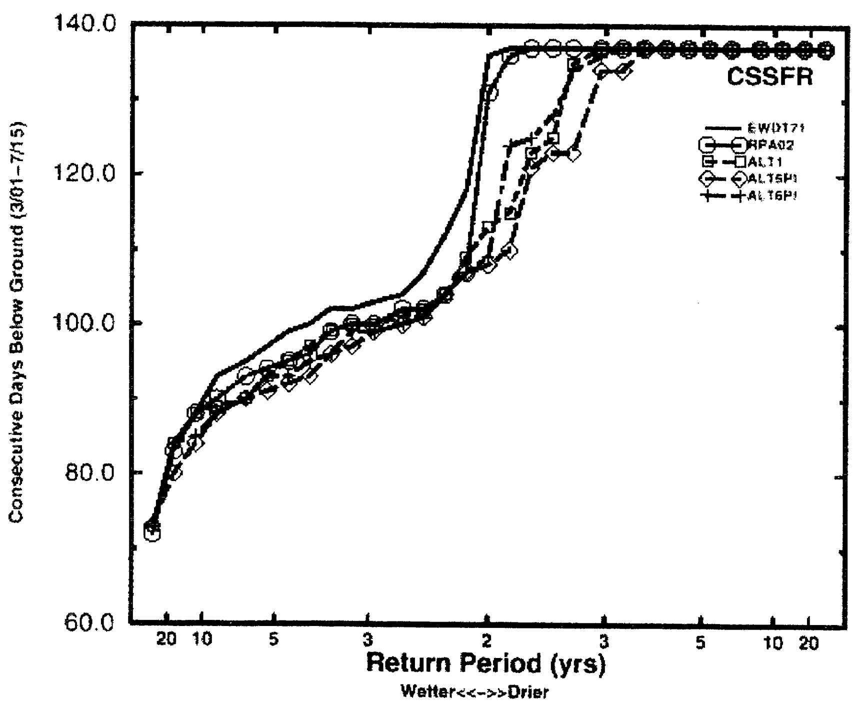


Figure 5.6. Continuous duration water level below ground surface from March 1 to July 15 for CSSS sub-population F.

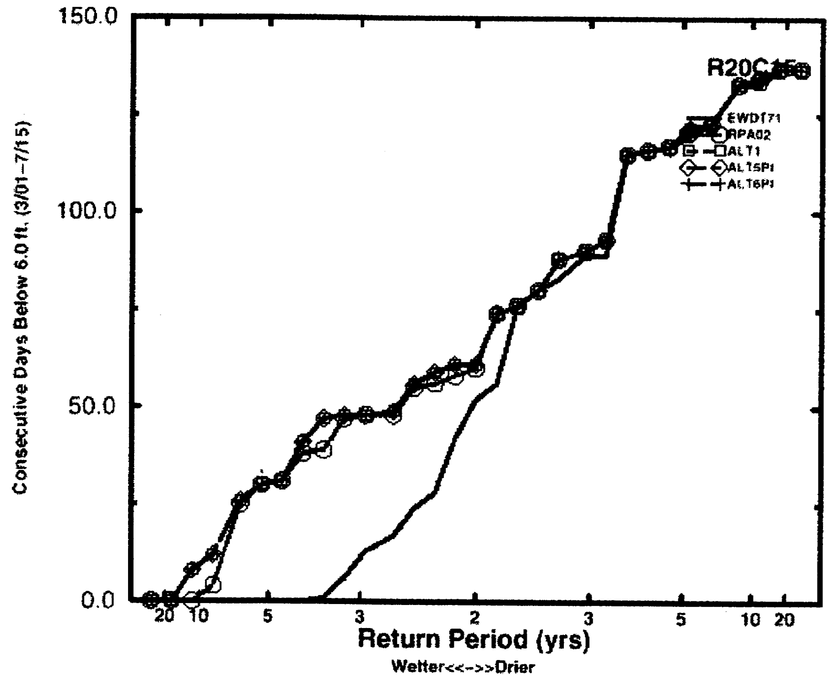


Figure 5.7. Continuous duration water level below ground surface from March 1 to July 15 for CSSS sub-population A at Row 20 Column 15.

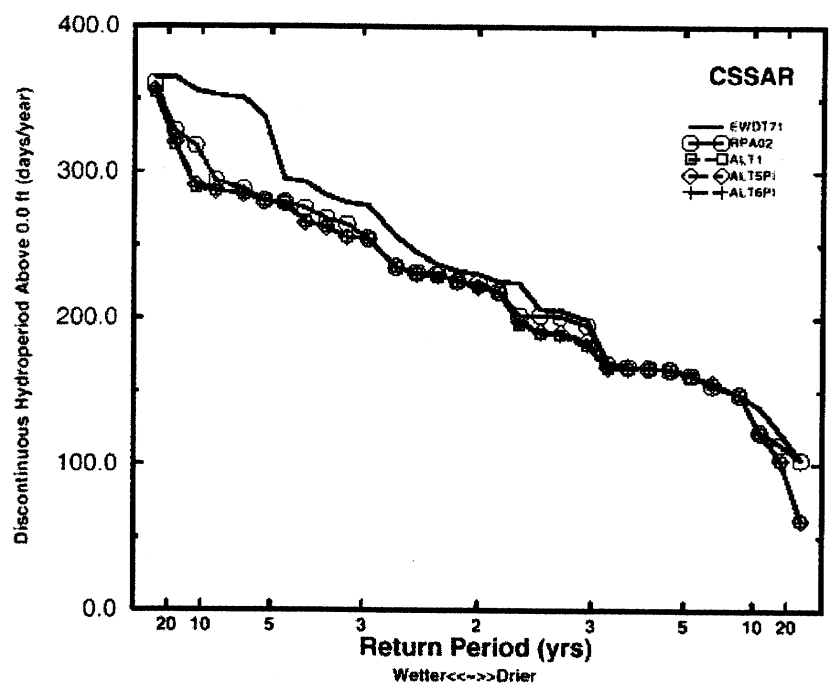


Figure 5.8. Discontinuous hydroperiod water depth above ground surface for CSSS sub-population A.

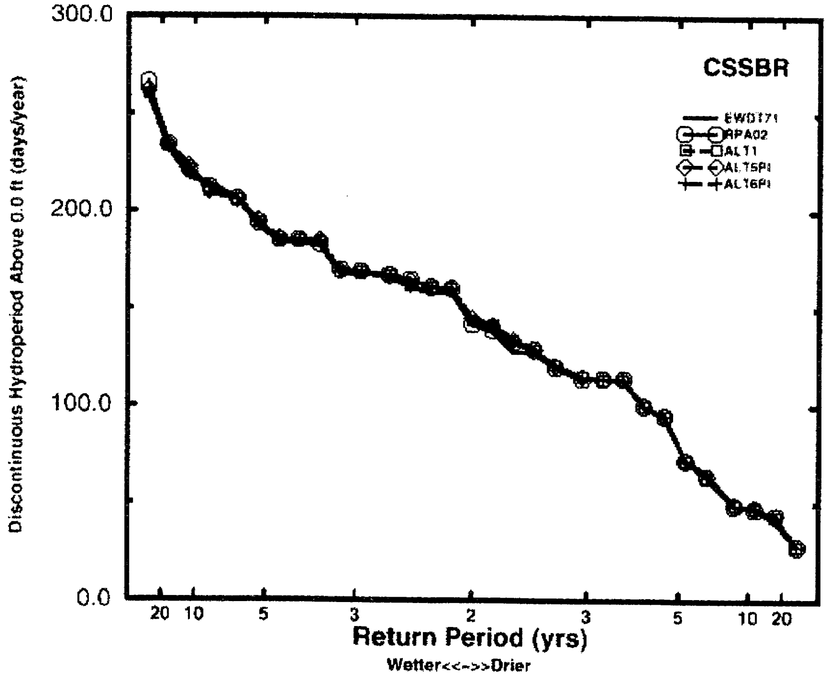


Figure 5.9. Discontinuous hydroperiod water depth above ground surface for CSSS sub-population B.

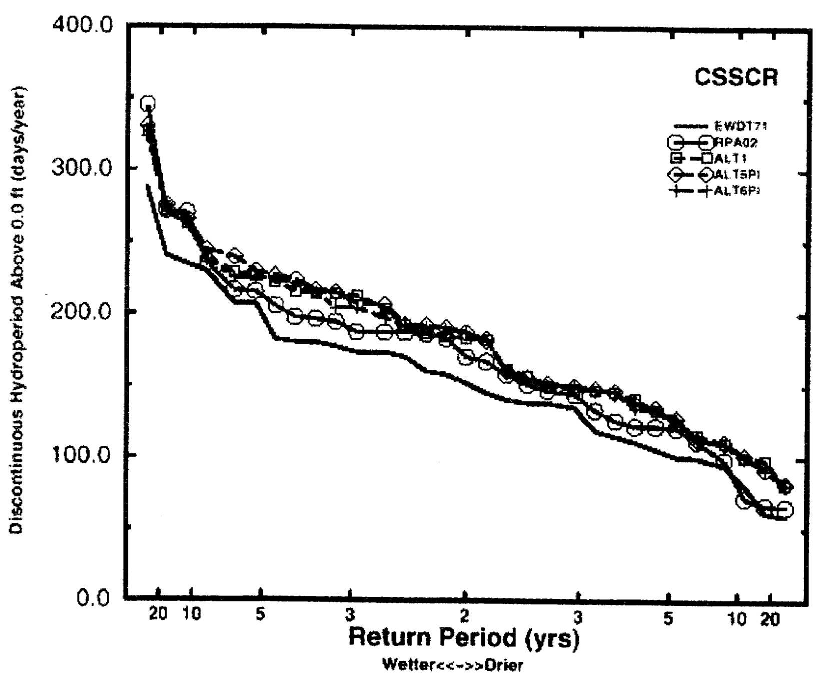


Figure 5.10. Discontinuous hydroperiod water depth above ground surface for CSSS sub-population C.

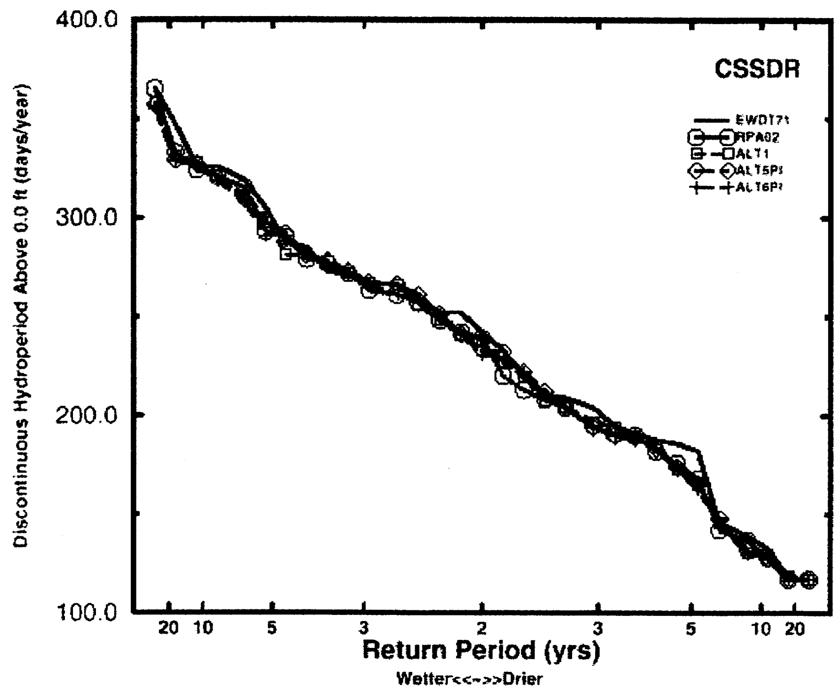


Figure 5.11. Discontinuous hydroperiod water depth above ground surface for CSSS sub-population D.

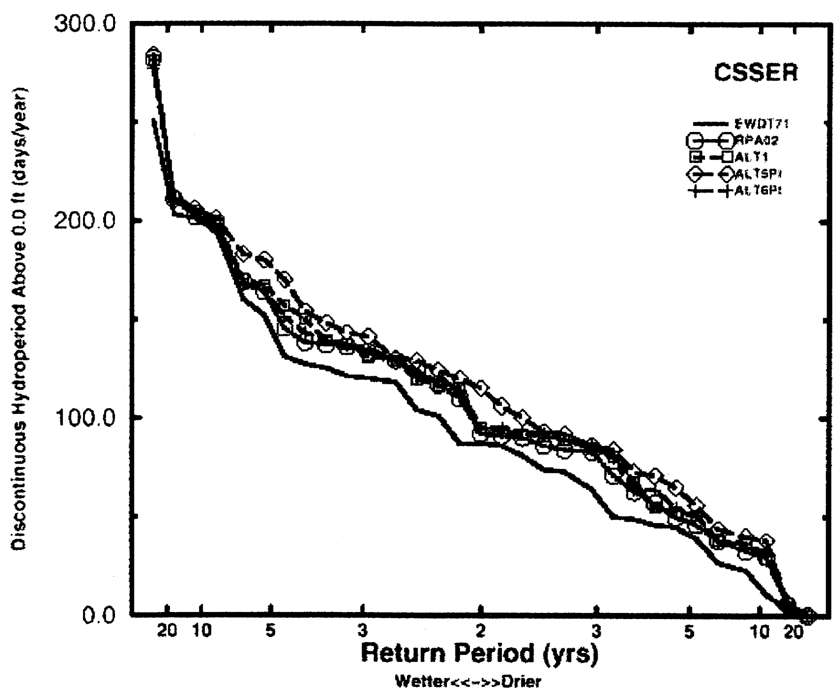


Figure 5.12. Discontinuous hydroperiod water depth above ground surface for CSSS sub-population E.

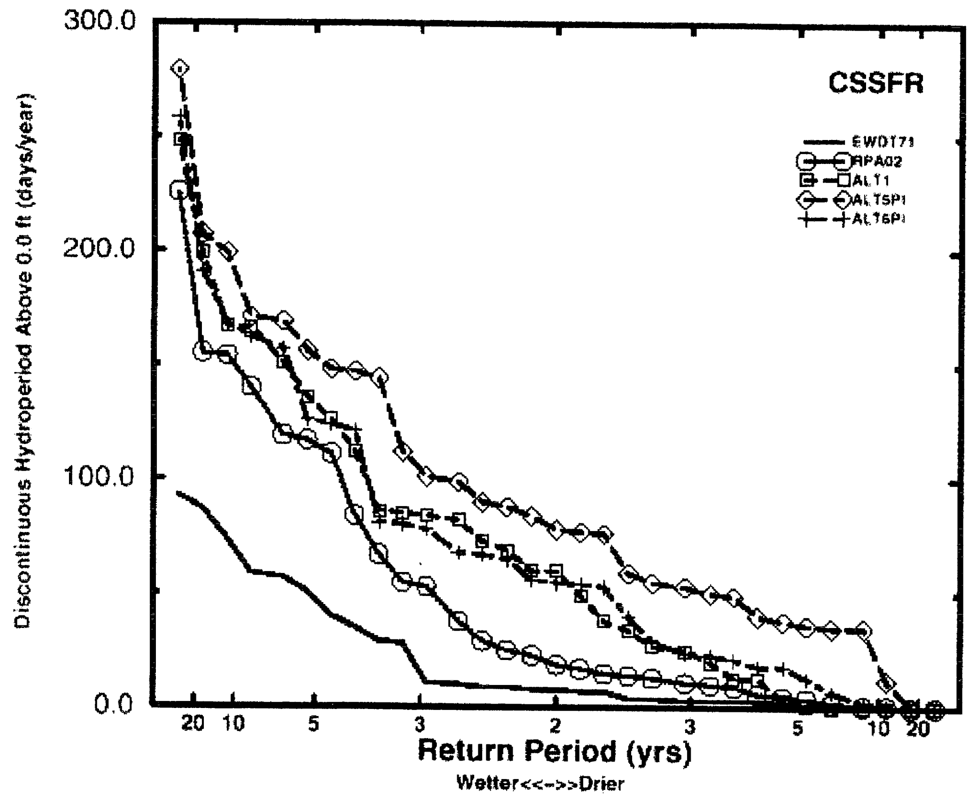


Figure 5.13. Discontinuous hydroperiod water depth above ground surface for CSSS sub-population F.

nesting. These categorizations are based on biological research documenting hydrologic conditions that support vegetation communities used by CSSSs (D. Jones and T. Armentano, pers. comm. 1999; S. Pimm, pers. comm., 2000). According to Curnutt et al. (1998), the CSSS population is distributed among six sub-populations (A - F) **(see Figure 5.14)**. Our analysis is presented by sub-population.

5.1.2 CSSS Sub-population A

Figure 5.8 shows SFWMM results for an area covering the majority of currently occupied CSSS habitat in sub-population A. The following inferences regarding the recovery and maintenance of CSSS habitat can be drawn for sub-population A from this information. All the alternatives except Experimental Water Delivery Test 7 Phase I (EWDT71) are the same for this measure with an average hydroperiod of about 240 days (7-8 months). The alternatives are on average slightly drier than EWDT71, and significantly drier than EWDT71 in years much wetter than average. An average hydroperiod of 240 days exceeds the upper limit of average hydroperiods expected to support marl prairie vegetation favorable to CSSS nesting. Field observations suggest that historical average hydroperiods in the portion of the sub-population A habitat that still supports CSSSs have been between 4 to 6 months. Since all alternatives substantially reduce the very long hydroperiods predicted for the wettest years under EWDT71, we would expect an improvement in the extent of suitable habitat in the sub-population A area under any of the alternatives.

From the information in **Figure 5.1** (also covering the majority of currently occupied habitat) we draw the following inferences regarding the window of nesting availability for sub-population A. All scenarios, except EWDT71 are similar over most years. Alt1, Alt5P1, Alt6P1 and RPA02 provide a significantly greater nesting window than EWDT71 in wetter than average years (60 days compared to 20 days in 8 out of 10 years). We further consider the window of nesting availability for sub-population A by evaluating simulated conditions specific to the site of the NP205 gage. From the information in **Figure 5.7**, which shows SFWMM results for a much smaller part of the sub-population A habitat representing NP205, we draw the following inferences. Alt1, Alt5P1, Alt6P1 and RPA02 provide a significantly greater nesting window than EWDT71 in average and wetter than average years (30 days compared to zero days in 8 out of 10 years).

We also note that **Figures 5.1 and Figure 5.7** show that none of the scenarios provides the 50-60 or 80 consecutive nesting days recommended by the AOU panel or the 60 days at NP205 required by the RPA in all years. Corps and NPS hydrologic experts have provided additional modeling runs to FWS that include closure of the S-12, S-343 and S-344 structures year round. Since these runs include closure of all structures that could affect the hydrology of sub-population A, the results show us the hydrologic conditions in sub-population A that we would expect to result solely from natural rainfall patterns, plus perhaps a small amount of seepage from WCA-3A. These results show that RPA targets for sub-population A would be met in the same number of years as they would be with closure of the structures as in Alt1, Alt5P1, Alt6P1 and RPA02. Therefore, FWS concludes that if these structures are closed in this way, any subsequent breeding failures observed in sub-population A would be due to natural rainfall variation rather than to Corps water management operations. The most recent CSSS survey results, showing a decline to only an estimated 128 individuals in this sub-population, underscore the importance of keeping this habitat area as dry as possible. Water managers should keep in mind that in saving this sub-population from extirpation, recovery of the habitat in this area (accomplished through hydroperiods of less than 180 days in most years) is just as important as providing a suitable nesting period (Pimm 2000).

5.1.3 CSSS Sub-population B

From the information in **Figure 5.9** the following inferences regarding the recovery and maintenance of CSSS habitat can be drawn for sub-population B. On average the hydroperiod for all scenarios is about 150 days (5 months). All scenarios are about the same. An average hydroperiod of about 150 days is within the limits of average hydroperiods expected to support vegetation favorable to CSSS nesting. From the information in **Figure 5.2** we draw the following inferences regarding the window of nesting availability for sub-population B. All scenarios are essentially the same, with all providing more than 40 days in all return periods, and more than 80 days in 7 out of 10 years. These conditions are considered favorable for persistence.

5.1.4 CSSS Sub-population C

From the information in **Figure 5.10** the following inferences regarding the recovery and maintenance of CSSS habitat can be drawn for sub-population C. On average the hydroperiod for all scenarios except EWDT71 ranges from about 170 to 180 days, with RPA02 slightly drier than the rest. All scenarios have a significantly longer average hydroperiod than the approximately 160 days for EWDT71. The 6 month average hydroperiod of Alt1, Alt5P1 and Alt6P1 appears to be near the upper limit of average hydroperiods expected to support marl prairie vegetation favorable to CSSS nesting.

From the information in **Figure 5.3** we draw the following inferences regarding the window of nesting availability for sub-population C. Alt1, Alt5P1 and Alt6P1 are all similar to RPA02 and all provide slightly fewer nesting days than EWDT71. All scenarios provide more than 80 days in 7 out of 10 years, a condition considered favorable for persistence. All scenarios provide more than 40 days in 8 out of 10 years, a condition also considered favorable for persistence.

5.1.5 CSSS Sub-population D

From the information in **Figure 5.11** the following inferences regarding the recovery and maintenance of CSSS habitat can be drawn for sub-population D. On average the hydroperiod for all scenarios is approximately 250 days, with EWDT71 perhaps slightly wetter under some conditions. As documented in Chapter 4, these SFWMM results do not reflect increased volumes of water delivered to this area under actual Alt1 operations. Similar operations are proposed under Alt5P1 and Alt6P1. Because of these extra water volumes, we expect that actual average hydroperiods in this area may be significantly longer than EWDT71. Since the 250 days reflected in the EWDT71 exceeds the upper limit of average hydroperiods expected to support vegetation favorable to CSSS nesting in the long term, we expect the even longer hydroperiods likely under Alt1, Alt5P1 and Alt6P1 would contribute to further reductions of suitable CSSS habitat in this sub-population. We also note that none of the scenarios examined is considered favorable, so significant habitat improvement would not be expected, even under RPA02.

From the information in **Figure 5.4** we draw the following inferences regarding the window of nesting availability for sub-population D. In general there is little difference between the scenarios examined. The difference between the scenarios is not consistent nor is it great and ranges from none to 10-15 days. Overall, RPA02 appears to provide slightly fewer nesting days during wet years, and is the only scenario that does not provide the 40 consecutive days in 8 out of 10 years considered favorable for persistence. However, the Chapter 4 analysis indicating that additional volumes of water would be delivered to this area under actual Alt1, Alt5P1 and Alt6P1 implementation suggests that these alternatives will not actually provide better performance than RPA02.

5.1.6 CSSS Sub-population E

As discussed in Chapter 4, SFWMM results presented in **Figures 5.5 and 5.12** are not considered reliable for the sub-population E area for those alternatives that include S- 332B operations (Alt1, Alt5P1 and Alt6P1). **Figures 5.5 and 5.12** should be fairly reliable for EWDT71 and RPA02 because S-332B is not used in these runs. Keeping this in mind, we review the SFWMM results for this area.

From the information in **Figure 5.12** the following inferences regarding the recovery and maintenance of CSSS habitat can be drawn for sub-population E. On average the hydroperiod for all scenarios ranges between about 80 and 120 days (2.5 - 4 months). EWDT71 is driest, Alt1, Alt6P1 and RPA02 are slightly wetter, and Alt5P1 is wettest. In the very wettest years, all scenarios perform similarly. Overall, Alt1 and Alt6P1 are very similar to RPA02, which FWS has determined is the best available representation of RPA requirements in this area. Alt5P1 appears to be slightly wetter than RPA02. An average hydroperiod of 2.5 – 4 months is expected to support *Muhlenbergia capillaris* dominated marl prairie vegetation or other marl prairie vegetation favorable to CSSS nesting.

From the information in **Figure 5.5** we draw the following inferences regarding the window of nesting availability for sub-population E. All scenarios are about the same. EWDT71 appears to provide slightly more nesting days in some wet years than the other scenarios examined. However, all scenarios provide more than 40 consecutive nesting days in all return periods, a condition considered favorable for persistence. In addition, all scenarios provide more than 80 days in 8 out of 10 years. This is a condition considered very favorable for persistence.

From this review of **Figures 5.5 and 5.12**, and noting that RPA02 includes increased canal stages along the eastern side of ENP that are expected to reduce the likelihood of large fires in the sub-population E area, FWS concludes that RPA02 will provide the minimum improvement in sub-population E habitat conditions necessary to reduce the chances of extirpation of this sub-population. EWDT71 does not appear to provide the same improvements in the CSSS habitat performance measures. In addition, EWDT71 does not provide increased canal stages or hydroperiods in the eastern portion of ENP that would reduce fire frequencies.

For analysis of Alt1, Alt5P1 and Alt6P1 effects on sub-population E, we turn to the analyses of S-332B operations presented in Chapter 4. All three methods of analysis conclude that S-332B operations are unlikely to make significant progress towards RPA required increases in water levels and hydroperiods in sub-population E. Additionally, the Chapter 4 analysis suggests that reduced canal stages along the eastern border of ENP are likely produce reduced hydroperiods in the marsh adjacent to these canals. Increased pumping at S-332B under Alt1 and Alt5P1 appears likely to compensate for these reduced canal stages only in a small area nearest the S-332B retention area. ENP marshes further north or south of the S-332B pump are expected to experience hydroperiods even lower than those under EWDT71 operations that were evaluated in the FWS' February 19, 1999, biological opinion. The second S-332B retention area that would be part of Alt6P1 may expand the area influenced by S-332B pumping somewhat. However, the even lower canal stages included in Alt6P1 suggest that some ENP marshes north and south of the pump would still experience even lower hydroperiods than EWDT71. These lower hydroperiods increase the time that marshes along the eastern border of ENP experience extreme dry conditions that are conducive to starting and supporting large fires. Accordingly, we conclude that Alt1, Alt5P1 and Alt6P1 are not likely to reduce the chances of catastrophic fire in sub-population E habitat as compared to EWDT71, and may actually increase the chances of catastrophic fire.

5.1.7 CSSS Sub-population F

As discussed above, SFWMM results presented in **Figures 5.6 and 5.13** are not considered reliable for the sub-population F area for those alternatives that include S- 332B operations (Alt1, Alt5P1 and Alt6P1). **Figures 5.6 and 5.13** should be fairly reliable for EWDT71 because S-332B is not used in these runs. Keeping this in mind, we review the SFWMM results for this area.

From the information in **Figure 5.13** the following inferences regarding the recovery and maintenance of CSSS habitat can be drawn for sub-population F. The greatest separation of scenarios (least similarity) is seen in sub-population F and their interpretation is the most problematic. On average the hydroperiod for all scenarios ranges from about 5 to 80 days, with Alt5P1 the "wettest" and EWDT71 the "driest". Alt 1 appears to be the most similar to RPA02, which FWS has determined is the best available representation of RPA requirements in this area, with an average hydroperiod of about 60 days. Alt1 and Alt6P1 are also predicted to have an average hydroperiod at about 60 days. This is considered just long enough (2 months) to support some recovery of vegetation favorable to CSSSs.

In sub-population F, Alt5P1 moves the farthest in a direction considered favorable to supporting vegetation for CSSS nesting. However, in much wetter than average years ("1-in-10" to "1-in-20") the predicted hydroperiod under Alt5P1, Alt6P1 and Alt1 is 6 to 12 months. In the short term, hydroperiods in this range have been observed to cause the conversion of suitable CSSS habitat to sawgrass-dominated vegetation unsuitable for CSSSs (Armentano et al. 2000; S. Pimm, pers. comm., 2000). It is not known what effect these conditions would have on recovering and sustaining vegetation favorable to CSSS nesting in the long term because recovery of vegetative communities suitable for CSSSs is possible with a return to shorter hydroperiods (Walters et al. 1999). By comparison, this year is much wetter than historical conditions (EWDT71) in sub-population B (the sub-population that has been most stable), for example, for the same return periods. The range of hydroperiods predicted for sub-population B is 15 to 210 days (6-1/2 months) compared to 0 to 280 days (9+ months) for sub-population F under scenario Alt5P1, and to a lesser extent, Alt1 and Alt6P1. For sub-population F, based only on average hydroperiod, Alt5P1 is most favorable at 3+ months. However, when considering the range of hydroperiods predicted, it may be more appropriate to consider RPA02, which is predicted to provide a range of hydroperiods similar to those in sub-population B, even though the average hydroperiod is only about 10 days.

In sub-population F, an average hydroperiod of 2 months is expected to support muhly dominated marl prairie vegetation favorable to CSSS nesting. However, the response of this area to a 2 month increase in hydroperiod, on average, is largely unknown. After almost no hydroperiod on average since the early 1980s, sparse sawgrass may occupy depressions. It is unknown what vegetation may occupy the areas of thin or non-existent soils around the depressions. Vegetation other than muhly may occupy CSSS habitat F after a period void of emergent vegetation and this vegetation may provide the structure necessary to support CSSSs at low to medium densities. It is unlikely that an increase in hydroperiod will reduce the woody invasion that has already occurred in a time frame that is biologically meaningful to the recovery of the CSSS (T. Armentano, pers. comm., 2000). The established woody vegetation in CSSS habitat F may take a very long time to die (T. Armentano, pers. comm., 2000). The demise of woody material can be expedited through additional actions that the Corps has recently agreed to fund (e.g. manual and/or mechanical removal, etc.).

From the information in **Figure 5.6** we draw the following inferences regarding the window of nesting availability for sub-population F. All scenarios provide more than 40 days in 8 out of 10 years, a condition considered favorable for persistence. All scenarios provide 80 days or more in 8 out of 10 years, a condition considered very favorable for persistence. EWDT71 appears to be most similar to RPA02 of the scenarios examined. The remaining alternatives provide similar performance. From this review of **Figures 5.6 and 5.13**, FWS concludes that RPA02 will provide improvements in sub-population F habitat conditions necessary to reduce the chances of extirpation of this sub-population.

For analysis of Alt1, Alt5P1 and Alt6P1 effects on sub-population F, we turn to the analyses of S-332B operations presented in Chapter 4. All three methods of analysis conclude that S-332B operations modeled in the IOP alternatives are likely to substantially increase water levels and hydroperiods in most of the southern part of sub-population F habitat. Hydroperiods and water levels are likely to decrease under these S-332B operations in the northern portion of the sub-population CSSS habitat F as compared to EWDT71 operations that were analyzed in the February 19, 1999, biological opinion. This further reduction in hydroperiod may further increase the risk of large fires in this area. For sub-population F habitat areas near S-332B, these operations are likely to produce very much wetter conditions than RPA02, raising concerns that habitat in this area would be converted to sawgrass-dominated vegetation unsuitable for CSSSs. Additionally, actual operations identical to those proposed in Alt1 have resulted in surface water spillover from the S-332B retention area into the CSSS habitat. Water quality monitoring has confirmed the likelihood of high phosphorus concentrations during at least some spillover events, and a flush of vegetation indicative of high phosphorus levels has already been observed directly adjacent to the retention area. The second retention area proposed as part of Alt6P1 should reduce the likelihood of spillover and should broaden the area influenced by S-332B pumping. However, very long hydroperiods and some spillover into CSSS habitat are likely even under Alt6P1, particularly when we take into account "pre-storm drawdowns", full capacity pumping during flood events, and additional water sent to this area due to actual S-335 operations, that are not included in the SFWMM modeling.

Therefore, we conclude that Alt1, Alt5P1 and Alt6P1 operations are likely to cause mixed effects in sub-population F habitat, with some areas drier than they were under EWDT71, some very much wetter, and others in a range favorable to recovery of CSSS habitat. The exact extent of each of these kinds of effects, and the resulting effects on CSSS numbers in this area, can only be determined through monitoring of actual operations. However, monitoring already conducted, and analysis presented in Chapter 4, constitute the best scientific information currently available on this topic, and support the FWS' conclusion that Alt1, Alt5P1 and Alt6P1 will likely cause additional adverse effects to CSSSs and CSSS habitat in sub-population F through flooding of areas closest to the S-332B retention area (s) and additional overdrainage of areas north of the retention area (s). These would be adverse effects above and beyond those anticipated in the FWS's February 19, 1999, incidental take statement, and would, therefore, be subject to the ESA's section 9 prohibitions. Although FWS fully supports building the second S-332B retention area and believes that this second retention area will reduce expected adverse effects, operations of the S-332B pump itself and of related structures must also be significantly adjusted from those presented in Alt6P1 in order to eliminate additional adverse effects resulting from flooding of some areas and overdrainage of others.

5.2 Snail Kite

Analysis of expected effects on snail kites resulting from the modeled alternatives was conducted using data presented in **Tables 5.1 through 5.11**. Values for each of the parameters were generated from SFWMM modeling results accepted by Corps, SFWMD and ENP hydrologists. To assess the possible effects of water management scenarios on snail kites, the following hydrologic conditions were examined: median hydroperiod, fraction of years with a hydroperiod less than 310 days, fraction of years in which there is a drying event, fraction of years in which there is a drying event lasting 30 days or longer, and fraction of years there is a drying event before May. These parameters were chosen for analysis because they are known to influence the populations of apple snails, the snail kite's main food source, that would be expected in areas that could provide habitat for nesting snail kites (Bennetts and Kitchens 1997; Darby et al. 1997; Bennets et al. 1998).

Values for each of these parameters were then examined for areas that supported regular snail kite nesting in areas affected by ISOP operations during actual EWDT71 operations. These areas are south WCA-3A (Indicator Region 14), the western side of WCA-3A, and the extreme southern portion of WCA-3A (**see Figure 5.14** Indicator Region Map). We assume that these values represent suitable conditions for snail kite nesting because successful snail kite nesting was consistently observed under these conditions during actual EWDT71 operations. Alternatives were evaluated by comparing suitable parameter values to those predicted by modeling in areas that could support snail kite nesting within WCA-2A, WCA-2B, WCA-3A, WCA-3B, NESS, and Shark Slough.

For the WCA-3A snail kite habitats that have historically supported the majority of nesting kites, the southern snail kite habitat (Southern WCA-3A Snail Kite habitat) shows all parameter values consistent with suitable habitat for all alternatives considered (RPA102, Alt1, Alt5P1, Alt6P2). The RPA predicted values appear consistent with suitable values for the Northern WCA-3A Snail Kite habitat. However, predicted values for Alt1, Alt5P1, and Alt6P1 appear inconsistent with suitable habitat in this same area. Mixed results are predicted for all alternatives considered for snail kite habitat in Indicator Region 14. Alternative rankings are based on

Indicator Regions, Flow Lines and Monitoring Locations

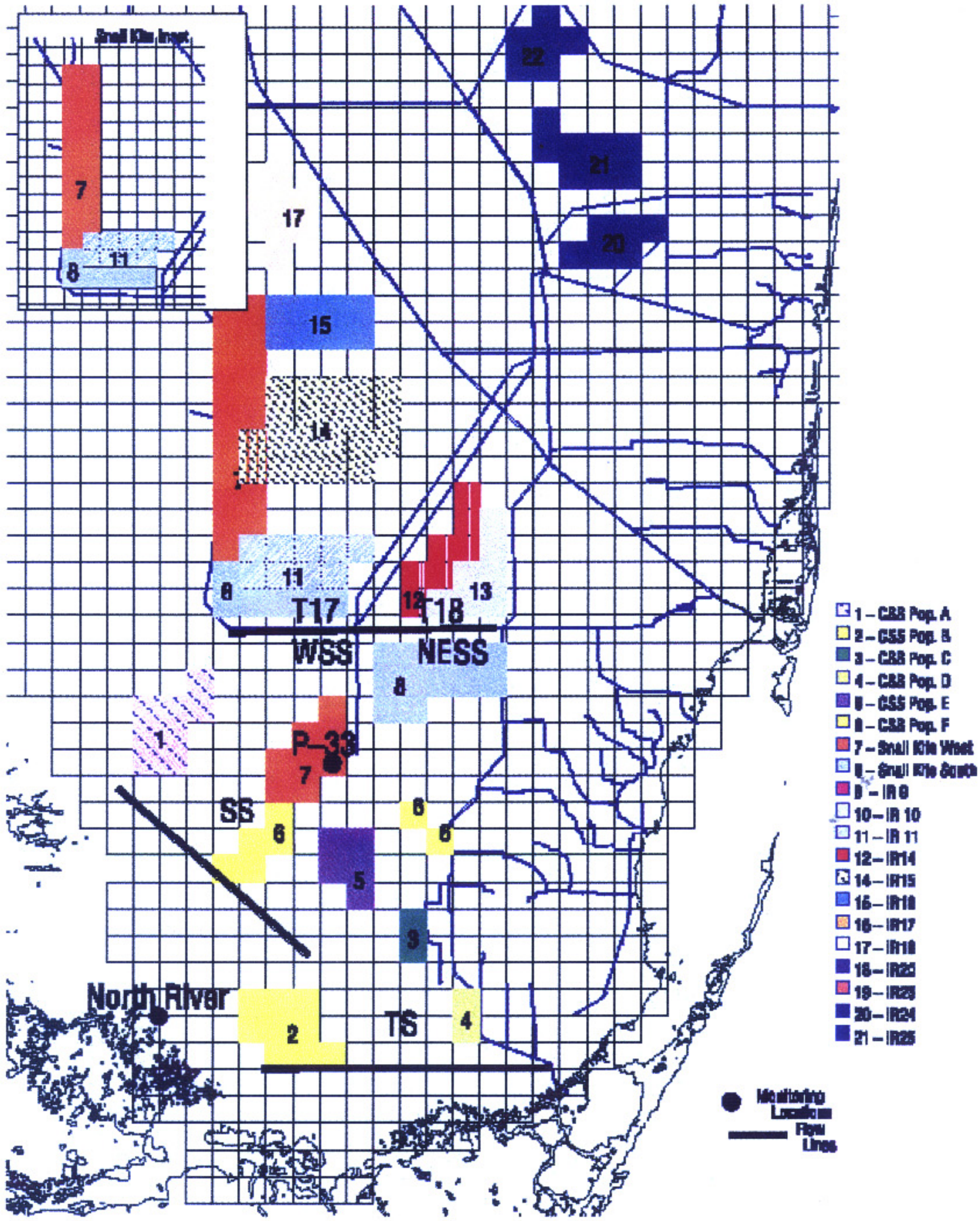


Figure 5.14. Indicator Regions, flow line transects, North River and P33 locations.

Table 5.1. Summary of selected measures related to the snail kite for the Southern 3A Snail Kite Habitat.

Indicator Region 14: Southern WCA-3A

Indicator	EWDT7I	RPA02	Alt1	Alt5P1	Alt6P1
Median Hydroperiod (days/year)	365	365	365	365	365
Fraction of years hydroperiod less than 310 days	0.03	0.05	0.05	0.05	0.05
Fraction of years there is a drying event	0.22	0.20	0.21	0.21	0.21
Fraction of years there is a drying event lasting 30 days or longer	0.09	0.06	0.09	0.06	0.06
Fraction of years there is a drying event before May	0.00	0.03	0.03	0.03	0.03

Table 5.2. Summary of selected measures related to the snail kite for the western 3B Snail Kite Habitat.

Indicator Region 15: Western WCA-3B

Indicator	EWDT7I	RPA02	Alt1	Alt5P1	Alt6P1
Median Hydroperiod (days/year)	365	365	365	365	365
Fraction of years hydroperiod less than 310 days	0.14	0.14	0.14	0.14	0.14
Fraction of years there is a drying event	0.33	0.32	0.36	0.34	0.34
Fraction of years there is a drying event lasting 30 days or longer	0.28	0.28	0.28	0.28	0.28
Fraction of years there is a drying event before May	0.21	0.21	0.21	0.21	0.21

Table 5.3. Summary of selected measures related to the snail kite for Indicator Region 16 Snail Kite Habitat.

Indicator Region 16: Eastern WCA-3B

Indicator	EWDT7I	RPA02	Alt1	Alt5P1	Alt6P1
Median Hydroperiod (days/year)	352	349	352	352	351
Fraction of years hydroperiod less than 310 days	0.34	0.34	0.38	0.38	0.38
Fraction of years there is a drying event	0.53	0.54	0.51	0.51	0.51
Fraction of years there is a drying event lasting 30 days or longer	0.44	0.44	0.44	0.44	0.44
Fraction of years there is a drying event before May	0.53	0.54	0.51	0.51	0.51

Table 5.4. Summary of selected measures related to the snail kite for Indicator Region 23 Snail Kite Habitat.

Indicator Region 23:

Indicator	EWDT7I	RPA02	Alt1	Alt5P1	Alt6P1
Median Hydroperiod (days/year)	356	356	356	356	356
Fraction of years hydroperiod less than 310 days	0.38	0.38	0.38	0.38	0.38
Fraction of years there is a drying event	0.53	0.53	0.53	0.56	0.56
Fraction of years there is a drying event lasting 30 days or longer	0.41	0.41	0.41	0.41	0.41
Fraction of years there is a drying event before May	0.45	0.47	0.47	0.47	0.47

Table 5.5. Summary of selected measures related to the snail kite for Indicator Region 24 Snail Kite Habitat.

Indicator Region 24:

Indicator	EWDT7I	RPA02	Alt1	Alt5P1	Alt6P1
Median Hydroperiod (days/year)	355	355	355	355	355
Fraction of years hydroperiod less than 310 days	0.28	0.28	0.36	0.36	0.36
Fraction of years there is a drying event	0.52	0.52	0.53	0.53	0.53
Fraction of years there is a drying event lasting 30 days or longer	0.44	0.44	0.44	0.44	0.44
Fraction of years there is a drying event before May	0.52	0.52	0.52	0.52	0.52

Table 5.6. Summary of selected measures related to the snail kite for Indicator Region 25 Snail Kite Habitat.

Indicator Region 25:

Indicator	EWDT7I	RPA02	Alt1	Alt5P1	Alt6P1
Median Hydroperiod (days/year)	355	355	355	355	355
Fraction of years hydroperiod less than 310 days	0.27	0.27	0.28	0.28	0.28
Fraction of years there is a drying event	0.58	0.58	0.60	0.60	0.60
Fraction of years there is a drying event lasting 30 days or longer	0.47	0.47	0.47	0.47	0.47
Fraction of years there is a drying event before May	0.37	0.37	0.37	0.37	0.37

Table 5.7. Summary of selected measures related to the snail kite for the Northern 3A Snail Kite Habitat.

Northern WCA-3A Snail Kite Habitat:

Indicator	EWDT7I	RPA02	Alt1	Alt5P1	Alt6P1
Median Hydroperiod (days/year)	362	365	350	350	350
Fraction of years hydroperiod less than 310 days	0.33	0.31	0.36	0.36	0.36
Fraction of years there is a drying event	0.52	0.49	0.62	0.62	0.62
Fraction of years there is a drying event lasting 30 days or longer	0.44	0.38	0.47	0.47	0.47
Fraction of years there is a drying event before May	0.47	0.47	0.55	0.55	0.55

Table 5.8. Summary of selected measures related to the snail kite for the Southern 3A Snail Kite Habitat.

Southern WCA-3A Snail Kite Habitat:

Indicator	EWDT7I	RPA02	Alt1	Alt5P1	Alt6P1
Median Hydroperiod (days/year)	365	365	365	365	365
Fraction of years hydroperiod less than 310 days	0.19	0.18	0.18	0.18	0.18
Fraction of years there is a drying event	0.30	0.30	0.31	0.31	0.31
Fraction of years there is a drying event lasting 30 days or longer	0.22	0.22	0.25	0.25	0.25
Fraction of years there is a drying event before May	0.22	0.22	0.23	0.23	0.23

Table 5.9. Summary of selected measures related to the snail kite for Indicator Region 10 Snail Kite Habitat.

Indicator Region 10: Mid Shark Slough

Indicator	EWDT7I	RPA02	Alt1	Alt5P1	Alt6P1
Median Hydroperiod (days/year)	363	365	365	365	365
Fraction of years hydroperiod less than 310 days	0.28	0.31	0.30	0.30	0.30
Fraction of years there is a drying event	0.53	0.49	0.46	0.46	0.46
Fraction of years there is a drying event lasting 30 days or longer	0.38	0.34	0.34	0.34	0.34
Fraction of years there is a drying event before May	0.44	0.41	0.37	0.37	0.37

Table 5.10. Summary of selected measures related to the snail kite for Indicator Region 11 Snail Kite Habitat.

Indicator Region 11: Northeast Shark Slough

Indicator	EWDT7I	RPA02	Alt1	Alt5P1	Alt6P1
Median Hydroperiod (days/year)	358	351	351	351	351
Fraction of years hydroperiod less than 310 days	0.31	0.33	0.35	0.35	0.35
Fraction of years there is a drying event	0.55	0.54	0.52	0.52	0.52
Fraction of years there is a drying event lasting 30 days or longer	0.31	0.38	0.41	0.41	0.41
Fraction of years there is a drying event before May	0.49	0.51	0.48	0.48	0.48

Table 5.11. Summary of selected measures related to the snail kite for Indicator Region 9 Snail Kite Habitat.

Indicator Region 9: SW Shark Slough

Indicator	EWDT7I	RPA02	Alt1	Alt5P1	Alt6P1
Median Hydroperiod (days/year)	352	350	352	352	352
Fraction of years hydroperiod less than 310 days	0.30	0.31	0.31	0.31	0.31
Fraction of years there is a drying event	0.65	0.60	0.66	0.66	0.66
Fraction of years there is a drying event lasting 30 days or longer	0.41	0.41	0.41	0.41	0.41
Fraction of years there is a drying event before May	0.50	0.51	0.50	0.50	0.50

results in these three historically important snail kite habitats.

In Shark Slough, parameter values are mixed for all alternatives in Northeast and SW Shark Slough (IR 9 and 11). Predicted values for all alternatives appear consistent with suitable habitat in Mid Shark Slough (IR 10). In WCA-3B, parameter values for western WCA-3B are consistent with current snail kite habitats under all alternatives. Results in Eastern WCA-3B, although mixed, are generally inconsistent with current snail kite habitats under all alternatives. Alternatives Alt1, Alt5P1, and Alt6P1 are predicted to perform slightly better than the RPA in this area. In WCA-2, predicted results are mixed across all alternatives in Indicator Regions 23, 24, and 25 (Northern 2A, Southern 2A, and 2B). The RPA appears to provide slightly better mixed results in Southern WCA-2A. These areas have historically supported relatively fewer nesting snail kites.

Also used in the evaluation of alternatives is a summary by basin of the fraction of years there is a drying event at or below ground surface classified as suitable conditions, marginal conditions, or unsuitable conditions for snail kites. The suitability classes are derived from Bennetts (pers. comm., 1998) and Bennetts et al. (1998). The classes represent relative habitat quality in relation to the time since a drying event. Suitable conditions are considered to be when drying events occur at a return frequency between "1-in-3" to "1-in-5" years, allowing for recovery of apple snail populations and maintenance of plant communities suitable for snail kite nesting and foraging. If drying events occur too frequently, greater than "1-in-2" years, the apple snail population will not have recovered to its full potential and so conditions are classified as unsuitable. If drying events occur at longer intervals, less than "1-in-6" year, then a cumulative process of habitat degradation will occur as plant communities change. This return frequency is also classified aas unsuitable. Return frequencies of "1-in-2" to "1-in-3" years, and "1-in-5" to "1-in-6" years are classified as marginal.

Table 5.12 summarizes habitat suitability designations based on predicted dryout frequency for each alternative. A font legend for this table is presented in **Table 5.13.** According to this performance measure, SW Shark Slough, NESS, Eastern WCA-3B, WCA-2A and WCA-2B are predicted to experience high dryout frequencies classified as unsuitable for snail kite habitat under EWDT71 and all alternatives. Mid Shark Slough (IR 10) is predicted to experience dryouts too frequently under EWDT71 conditions and is classified as unsuitable. The RPA, Alt1, Alt5P1, and Alt6P1 would reduce slightly the frequency of dryouts into the marginal range of habitat suitability in Mid Shark Slough. This is consistent with low usage of these areas by nesting snail kites in recent years. In southern WCA-3A (IR 14) and Southern WCA-3A Snail Kite Habitat, dryout frequencies are consistent with suitable conditions under EWDT71 and all alternatives. Predicted dryout frequencies indicate suitable conditions in western WCA-3B for EWDT71 and the RPA, and marginal conditions under Alt1, Alt5P1, and Alt6P1. However, differences among alternatives in western WCA-3B are small. The Northern WCA-3A Snail Kite Habitat is predicted to experience dryouts too frequently under EWDT71, Alt1, Alt5P1, and Alt6P1 conditions and are classified as unsuitable. The RPA would reduce the frequency of dryouts just barely into the marginal range of habitat suitability in the Northern WCA-3A Snail Kite Habitat.

Looking at dryout frequencies by alternative and concentrating on the historically important snail kite habitats, EWDT71 and all the alternatives considered appear to consistently provide suitable habitat in two of the three historically important kite habitats (IR 14 and Southern WCA-3A Snail Kite Habitat). The RPA is the only alternative to provide marginal habitat in a third historical area along with suitable conditions in the remaining two. The RPA, along with EWDT71, also provides suitable conditions in western WCA-3B, compared to marginal conditions predicted from the remaining alternatives.

Overall, using both evaluation methods and focusing on historically important snail kite habitats, EWDT71 and the RPA appear to slightly outperform the other alternatives.

5.3 Wood Stork

Analysis of alternative impacts on wood storks were evaluated using the performance measure proposed by Ogden (1998). This performance measure was developed using hydrological indicators which best measure the recovery of optimum foraging conditions for wood storks and

Table 5.12. Summary by basin of the fraction of years there is a drying event below ground surface, classified as suitable, marginal or unsuitable.

Indicator	EWDT7I	83BaseM	RPA02	ALT1	ALT5PI	ALT6PI
Indicator Region 9: SW Shark Slough	0.65	0.47	0.60	0.66	0.66	0.66
Indicator Region 10: Mid Shark Slough	0.53	0.43	0.49	0.46	0.46	0.46
Indicator Region 11: Northeast Shark Slough	0.55	0.84	0.54	0.52	0.52	0.52
Indicator Region 12:	0.62	0.67	0.77	0.86	0.84	0.86
Indicator Region 13:	0.92	0.92	0.96	0.96	0.96	1.00
Indicator Region 14: Southern WCA-3A	0.22	0.23	0.20	0.21	0.21	0.21
Indicator Region 15: Western WCA-3B	0.33	0.39	0.32	0.36	0.34	0.34
Indicator Region 16: Eastern WCA-3B	0.53	0.70	0.54	0.51	0.51	0.51
Southern WCA-3A Snail Kite Habitat:	0.30	0.31	0.30	0.31	0.31	0.31
Northern WCA-3A Snail Kite Habitat:	0.52	0.54	0.49	0.62	0.62	0.62
Indicator Region 23:	0.53	0.53	0.53	0.53	0.56	0.56
Indicator Region 24:	0.52	0.52	0.52	0.53	0.53	0.53
Indicator Region 25:	0.58	0.58	0.58	0.60	0.60	0.60

Table 5.13. Legends for determination of classifications for kite performance measure summary tables of drying events below ground surface classified as suitable, marginal or unsuitable (note Range, f is the exceedence frrequency of a drought).

Condition	Range
Unsuitable	$f<=0.16$
Marginal	$0.16<f<= 0.19$
Suitable	$0.20<=f<= 0.33$
Marginal	$0.33<f<=0.49$
Unsuitable	$f>0.49$

is generally accepted as the best performance measure so far developed. Ogden and others have explored other methods of evaluating expected impacts on wood storks resulting from alternative water management scenarios, but have so far not found another method that better predicts performance when compared with data on historical wood stork foraging and nesting patterns (J. Ogden, pers. comm., 2000).

The target for the Ogden (1998) wood stork performance measure is to approximate NSM predicted flow volumes and hydroperiod durations for Shark Slough and Taylor Slough. To evaluate an alternative, values for each of these elements are converted to a ratio of the NSM value. A final, weighted score is then calculated using a weighting of two for the hydroperiod durations, a weighting of three for the Shark Slough flow volume and a weighting of one for Taylor Slough flow volume. Final scores within 15% of NSM are considered optimal, values within 16% to 30% of NSM are considered good, values within 31% to 50% are considered marginal and values less than 50% of NSM are considered unsuitable. **Table 5.14** summarizes scores for alternatives analyzed in this report. All values for predicted flow volumes and hydroperiod durations were obtained from summary tables provided by the Corps and ENP.

Review of the inundation duration values show that all alternatives provide nearly identical conditions. The RPA and all the alternatives are predicted to provide a 1 – 3% increase in upper and lower Shark Slough durations compared to EWDT71. All of the alternatives are predicted to provide greater than NSM flow volumes to Taylor slough, with the EWDT71 providing the largest average annual Taylor Slough flow volumes at 162% of NSM and the RPA providing the least at 144% of NSM. A review of flow volumes to Shark Slough shows that all alternatives, including the RPA and EWDT71, provide nearly identical conditions, ranging from 33% of NSM for Alt6P1 to 35% of NSM for EWDT71.

The weighted scores provide an overall picture of conditions relating to expected wood stork nesting success for each alternative. All weighted scores with Taylor Slough volumes included are slightly above 50% of NSM and range from 54% for the RPA to 57% for EWDT71. Using this metric, all alternatives are considered to provide marginal conditions for consistent wood stork nesting success in the historical ENP colonies. Without Taylor Slough volumes all alternatives, including the RPA and EWDT71, have nearly identical scores of 36% - 37% of NSM. Using this metric, the weighted scores are all below 50% of NSM values and therefore all scenarios are considered to provide unsuitable conditions for wood stork nesting success.

5.4 American Crocodile and West Indian Manatee

Expected alternative performance relative to American crocodile and West Indian manatee habitats was evaluated through comparison of predicted salinity regimes, average annual flow volumes and monthly flow distributions. Our analysis focuses on Florida Bay and Shark Slough estuary habitats that are expected to be most affected by IOP operations. Possible effects to Biscayne Bay habitats are also noted.

5.4.1 Florida Bay and Shark Slough Estuaries

Table 5.14. Summary of hydrologic performance measures related to the wood stork.

Indicator	NSM	EWDT71	RPA	ALT1	ALT5PI	ALT6PI
IR 9 inundation [a]	154	54	58	56	58	56
IR 10 inundation [b]	175	70	74	75	75	75
IR 9 Ratio to NSM	1.0	0.35	0.38	0.36	0.38	0.36
IR 10 Ratio to NSM	1.0	0.40	0.42	0.43	0.43	0.43
IR Mean	1.0	0.38	0.40	0.40	0.41	0.40
Taylor Slough [c]	97	157	140	151	144	144
Shark Slough [d]	1587	554	533	533	542	529
Taylor Slough Ratio to NSM	1.0	1.62	1.44	1.56	1.48	1.48
Shark Slough Ratio to NSM	1.0	0.35	0.34	0.34	0.34	0.33
Flow Mean	1.0	0.99	0.89	0.95	0.91	0.91
Total Score [e]	1.0 (1.0)	0.57.(0.36)	0.54 (0.36)	0.56 (0.36)	0.55 (0.37)	0.55 (0.36)

[a] Average number of weeks of continuous inundation

[b] Average number of weeks of continuous inundation
[c] Annual Flow Volume, in thousands of acre-ft
[d] Annual Flow Volume, in thousands of acre-ft
[e] Total score calculated with and (without) Taylor Slough scores. The final weighted score is calculated using a weighting of two for the hydroperiod durations, a weighting of three for the Shark Slough flow volume, and a weighting of one for Taylor Slough flow volume.

Expected salinity regimes were examined for the North River mouth only. Salinity regimes were calculated based on predicted stages at the P-33 gage according to performance measures developed during the Restudy (C&SF Restudy 1998) and are presented in **Figure 5.15.** Although the Restudy performance measure provides predicted salinities for the Joe Bay, Little Madeira Bay, Terrapin Bay, and Garfield Bight estuarine areas in Florida Bay as well as for North River, subsequent authors have found that salinities in these other areas do not closely correlated with P-33 stages due to the greater influence of Taylor Slough flows in these areas (Van Lent et al. 1999). Therefore, we will use only the closely correlated North River predictions. Salinity relationships for other estuarine areas that may be affected by IOP operations are not yet available. The desired condition is to increase the percentage of time when low salinity (<20 ppt) is expected, and decrease the percentage of time when moderate (20–40 ppt) or high (>40 ppt) salinities are expected. These categories are based on discussions with crocodile and manatee researchers and reflect data showing that crocodile hatchling survival is likely reduced during times of high salinity, and that manatees generally prefer lower salinity habitats (FWS 1999).

Results of the salinity predictions show very little difference among alternatives considered. Alt1PI, Alt5P1, and Alt6P1 are nearly identical with each other and with EWDT71. The RPA

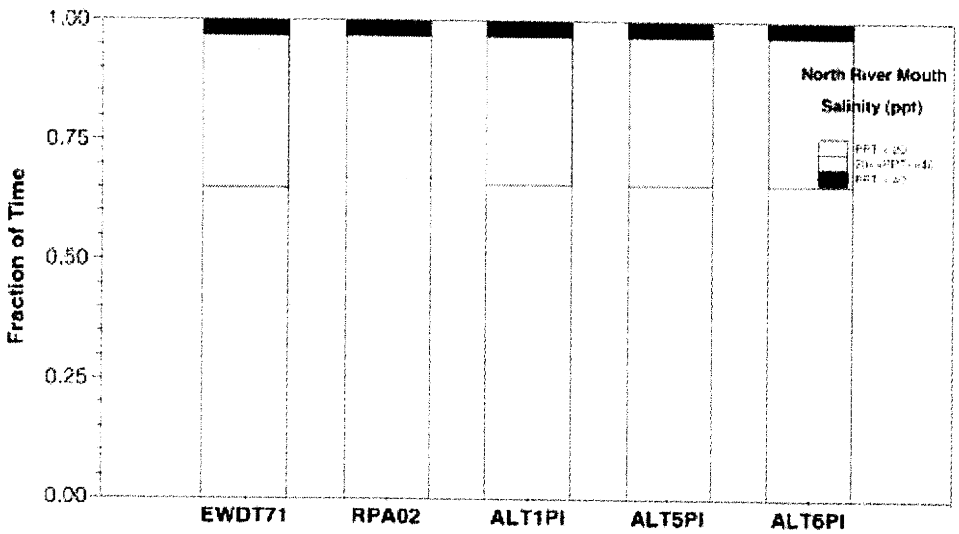


Figure 5.15. Salinity estimates for the North River based on P-33 stages.

shows a very slight increase in the predicted fraction of time for low salinity events as compared to EWDT71. The fraction of high salinity events predicted for EWDT71 and all the alternatives is the same.

As the possible effects on crocodiles and manatees are related to fresh water in flows into the estuaries, it is useful to examine simulated annual flow volumes. The desired condition is to minimize decreases in annual flow volumes into Shark Slough and Taylor Slough.

In addition to flow volume it is useful to look at the monthly distribution of flows towards the estuarine crocodile and manatee habitat of northeastern Florida Bay especially during the initial growth period for crocodile hatchlings, from August – December. The desired condition is to minimize the loss of monthly flows during August – December as compared EWDT71.

Figure 5.16 illustrates predicted frequency of average annual flows towards the Shark Slough estuarine areas, and **Figure 5.17** illustrates the average monthly distribution of these flows. **Figure 5.16** shows that little difference in average annual flows is expected during very wet years, very dry years, and during "average" or "1-in-2" years. For "1-in-3" dry years and "1-in-3" to "1-in-5" wet years, predicted flows for Alt1, Alt5P1, and Alt6P1 are nearly identical and show somewhat lower flows than EWDT71 and the RPA. The biological significance of these flow changes is most apparent in **Figure 5.17**, which shows that all alternatives (Alt1, Alt5P1, Alt6P1, and the RPA) would produce lower dry season flows to the Shark Slough estuaries than EWDT71. **Figure 5.17** also shows alternatives Alt1, Alt5P1, and Alt6P1 are expected to produce lower wet season flows to Shark Slough estuaries compared to EWDT71 and the RPA. Overall, based on flow, EWDT71 would be expected to provide the most consistent lower salinity conditions preferred by manatees, followed by the RPA, with all other alternatives third. Again, based on flow, EWDT71 and to a slightly lesser degree the RPA would be expected to

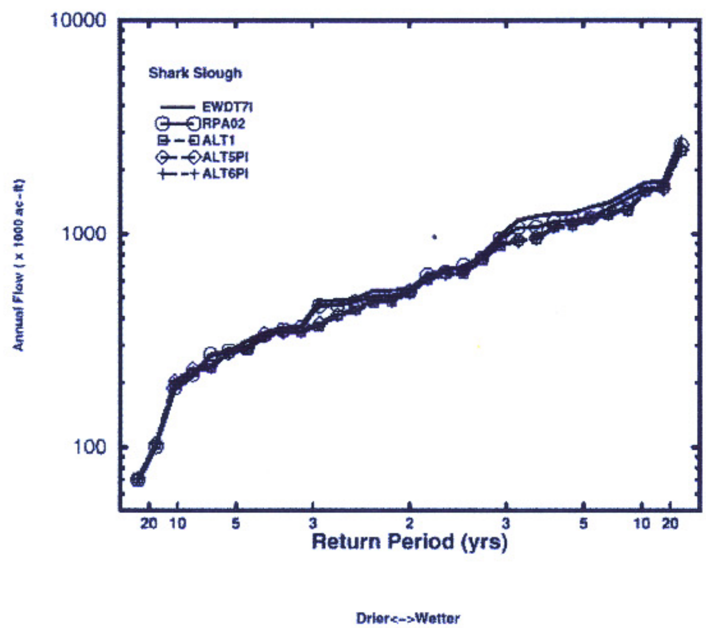


Figure 5.16. Frequency of average annual flows to Shark Slough.

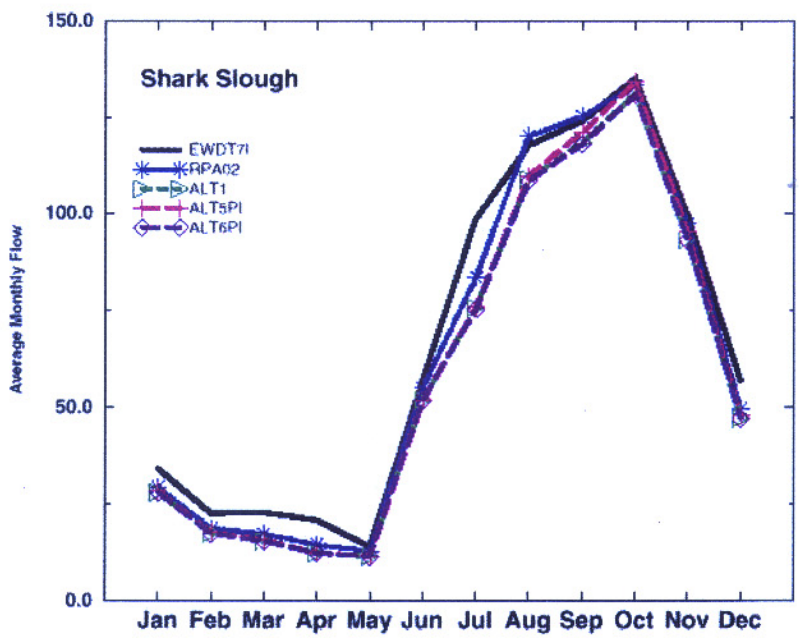


Figure 5.17. Average total monthly flow in acre-feet to Shark Slough.

produce the lowest salinities during the August – September crocodile hatchling period, with all other alternatives producing higher relative salinities. With respect to flow volumes and monthly distribution there is no substantial difference between Alt1, Alt5P1, and Alt6P1.

In evaluating these results, it is important to keep the S-332B analysis presented in Chapter 4 in mind. This analysis shows that modeled flows toward the Shark Slough estuaries observed for Alt1, Alt5P1, and to a lesser extent Alt6P1 could be unrealistically high when compared to actual observations of S-332B operations. With respect to providing favorable manatee and crocodile habitat, this analysis further supports our ranking of EWDT71 above the RPA, followed by all other alternatives considered (Alt1, Alt5P1, and Alt6P1) for this performance measure.

Figure 5.18 illustrates predicted frequency of average annual flows through Taylor Slough towards Florida Bay, and **Figure 5.19** illustrates the average monthly distribution of these flows. **Figure 5.18** shows that expected average annual flows differ the most (although relatively slightly) among alternatives during the driest years, with the RPA showing the lowest flows during these conditions, followed by Alt5P1 and Alt6P1, then Alt1 and EWDT71. Expected flows over the rest of the distribution demonstrate a similar ranking although differences among alternatives are even less distinguishable. In the wettest of years predicted flows for EWDT71 are slightly higher than all the alternatives whose simulated flows for these conditions are essentially the same.

Figure 5.19 shows that the monthly distribution of flows toward Florida Bay would be the same for all alternatives during the dry season. During the early wet season, all alternatives would reduce flows somewhat as compared to EWDT71, with Alt1 reducing flows the least, followed by Alt5P1 and Alt6P1, and then the RPA with the relatively greater reduction in early wet season flows. During the August – September crocodile hatchling period, the early wet season ranking of alternatives is retained although the differences between scenarios is reduced.

Overall, EWDT71 would likely provide the most consistent flows and therefore more favorable habitat conditions for the relatively few manatees using northeast Florida Bay. Overall for crocodiles, EWDT71 appears to provide the more favorable habitat conditions in Florida Bay, followed by Alt1, then Alt5P1 and Alt6P1, and lastly the RPA. However, it should be noted that the relative differences between alternatives is very slight.

5.4.2 Biscayne Bay Estuaries

Both manatees and crocodiles regularly use Biscayne Bay estuarine habitats and nesting crocodiles are common at Florida Power and Light's Turkey Point Nuclear Electrical Generating Facility in southern Biscayne Bay (USFWS 1999). **Figures 5.20 and 5.21** show that the expected monthly distribution of flows to central and southern Biscayne Bay would be the same for all alternatives during the early dry season. During the late dry season Alt1, Alt5P1, and Alt6P1 are essentially the same and provide higher flows compared to EWDT71 and the RPA. During the early wet season, the late dry season ranking of alternatives is retained although the

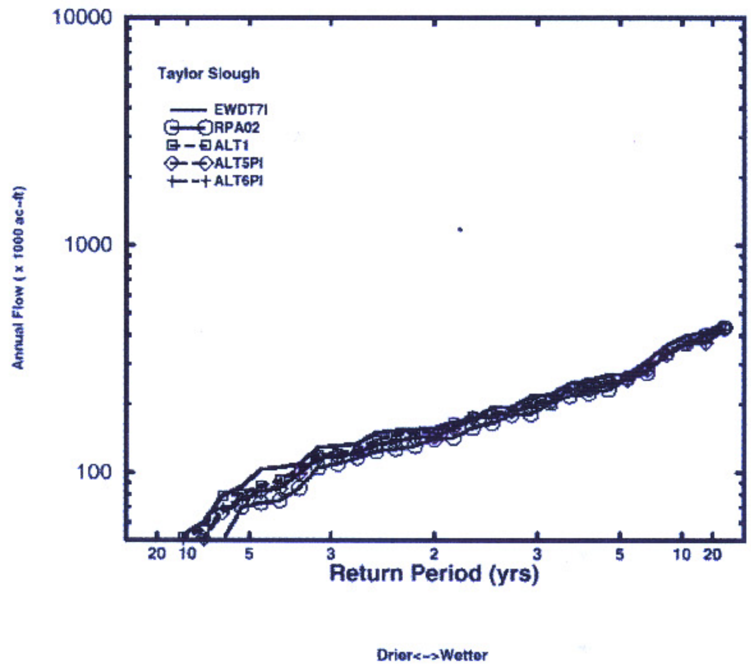


Figure 5.18 Frequency of average annual flows to Taylor Slough.

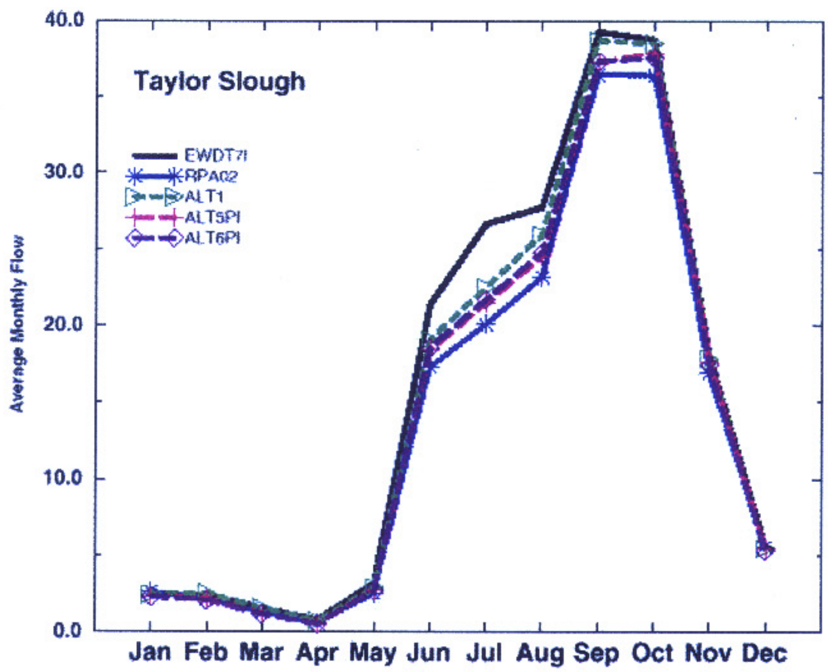


Figure 5.19. Average total monthly flow, in acre-feet to Taylor Slough.

differences between scenarios is much reduced. During the late wet season, including the August – October timeframe when crocodile hatchlings are most sensitive to high salinities, the RPA provides higher flows to central and southern Biscayne Bay compared to all of the alternatives including EWDT71. These increased late wet season flows may provide more suitable habitat for crocodiles in central and southern Biscayne Bay. Manatees, however, may benefit from decreased salinities expected under Alt1, Alt5P1, and Alt6P1 in central and southern Biscayne Bay during the January – April period when manatees often use this area as a cold weather refugia.

5.5 Compilation of Threatened and Endangered Species Evaluations

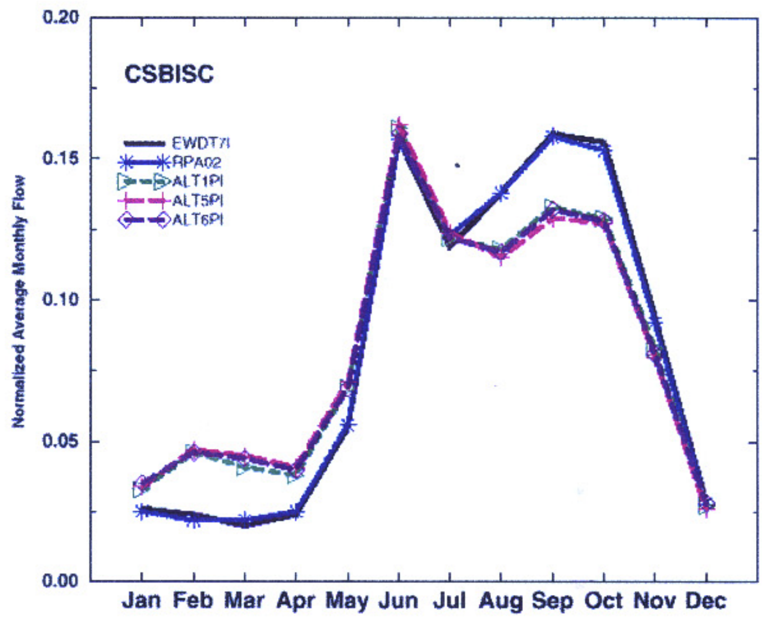
In this chapter a number of performance measures were evaluated in the assessment of the hydrologic effects of the proposed IOP plans on threatened and endangered species throughout the southern Everglades. To assist in the determination of the performance of the plans from this diverse group of metrics a method was developed to allow for the compilation of all the measures into a number of matrices suitable for the decision making process. These individual matrices can then be used to form a single matrix for the purpose of rendering a decision on the DOI preferred alternative.

The method employed arranges all of the alternatives for each performance measure in a hierarchical order from worst to best performance. Numerical scores from 1 to 8 were then assigned to each of the alternatives based on this hierarchical order, using the following equation:

$$Score = n + \frac{n+m-1}{p-1} + m - 1$$

where n is the number of alternatives lower in the hierarchy, m is the number of alternatives of equivalent rank in the hierarchy, and p is the total number of alternatives considered (in this case 8). The lowest performing alternative for a given performance measure was assigned a score of 1 and the remaining scores were calculated based on the equation above. Non-integer scores were rounded up to the next highest integer. The resulting scores for all alternatives for each performance measures for threatened and endangered species are presented in **Tables 5.15 and Table 5.16.** For each category of the performance measures for both priority 1 and 2 project objectives an aggregated mean score was calculated and is shown at the bottom of each table. These scores will be aggregated for each of the project priorities, normalized based on the total number of performance categories and are shown in **Appendix C**.

The information in **Tables 5.15 and 5.16** is graphically illustrated in **Figures 5.22 and 5.23. Figure 5.22** suggests that of the operational plans simulated, the alternative most likely to meet the priority 1 objectives as related to the CSSS is the RPA. It should be noted that for this metric only a pass fail criteria was applied. The EWDT71 alternative was identified as most suitable in meeting the other listed species **(Figure 5.23)**. Failure of the RPA in meeting or exceeding the performance of EWDT71 is mostly linked to limitations imposed on inflows to NWSS in the RPA. These limitations result in decreased flows towards Shark Slough estuaries relative to EWDT71 , which is reflected in the manatee and crocodile performance scores show in **Figure 5.23.**



Figures 5.20. Average total monthly flow, in acre-feet to central Biscayne Bay.

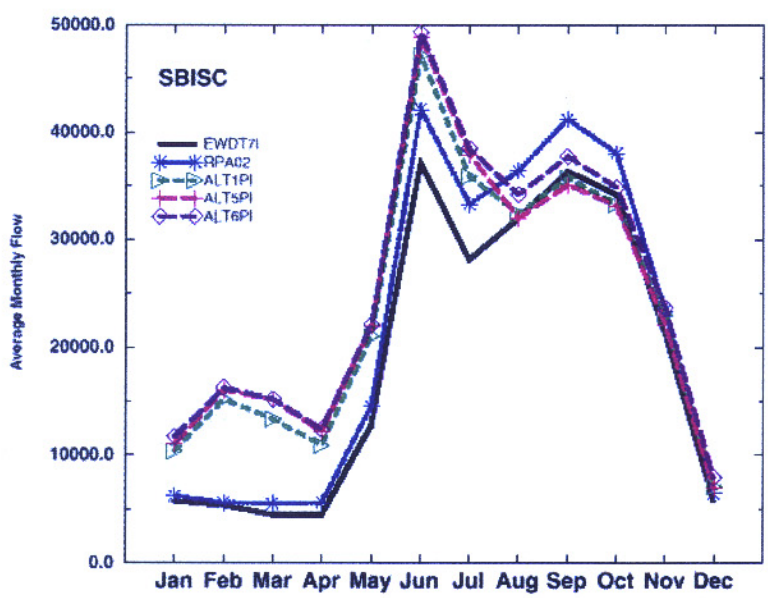


Figure 5.21. Average total monthly flow, in acre-feet to southern Biscayne Bay.

Table 5.15. Interim Operating Plan Performance Scores for Priority One Pre- Screening.

CAPE SABLE SEASIDE SPARROW PROJECT REQUIREMENTS								
	Alternative Requirements (Pass/Fail)							
	Base Condition	Corps Preferred Alternative	Other Alternatives					
	Base 95	Alternative 5	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 6	
PERFORMANCE MEASURES	Test 7 Phase 1	Phase 1-IOP 2B*	ISOP 9dR	IOP 2B	IOP 2A	IOP 3A	IOP 5a	RPA02
PRIORITY 1 PROJECT OBJECTIVES								
1-Evaluate Effects on Cape Sable Seaside Sparrow								
1A-Cape Sable Seaside Sparrow (Western Population)								
1A1-Nesting Habitat Availability	Fail	Pass	Pass	Fail	Fail	Fail	Pass	Pass
1B-Cape Sable Seaside Sparrow (Eastern Populations)								
1B1-Nesting Habitat Availability	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Pass
1B2-Habitat Vegetation Maintenance	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Pass
	Alternative Requirements Scores (Pass=1 and Fail=0)							
	Base Condition	Corps Preferred Alternative	Other Alternatives					
	Test 7 Phase 1	Alternative 5	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 6	RPA
		Phase 1-IOP 2B*	ISOP 9dR	IOP 2B	IOP 2A	IOP 3A	IOP 5a	
PRIORITY 1 PROJECT OBJECTIVES								
1-Evaluate Effects on Cape Sable Seaside Sparrow								
1A-Cape Sable Seaside Sparrow (Western Population)								
1A1-Nesting Habitat Availability	0	1	1	0	0	0	1	1
Objective Subtotal Mean Score	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**1**
1B-Cape Sable Seaside Sparrow (Eastern Populations)								
1B1-Nesting Habitat Availability	0	0	0	0	0	0	0	1
1B2-Habitat Vegetation Maintenance	0	0	0	0	0	0	0	1
Objective Subtotal Mean Score	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**

Table 5.16. Interim Operating Plan Performance Scores for Priority One and Two Objectives.

CAPE SABLE SEASIDE SPARROW PROJECT REQUIREMENTS					
	Alternative Scores				
	Base Condition	Corps Preferred Alternative	Other Alternatives		
	Test 7 Phase 1	Alternative 5	Alternative 1	Alternative 6	RPA
		Phase 1-IOP 2B*	ISOP 9dR	IOP 5a	RPA02
PERFORMANCE MEASURES					
PRIORITY 1 PROJECT OBJECTIVES					
1-Evaluate Effects on Cape Sable Seaside Sparrow					
1A-Cape Sable Seaside Sparrow (Western Population)					
1A1-Nesting Habitat Availability	Fail	Pass	Pass	Pass	Pass
1B-Cape Sable Seaside Sparrow (Eastern Populations)					
1B1-Nesting Habitat Availability	Fail	Fail	Fail	Fail	Pass
1B2-Habitat Vegetation Maintenance	Fail	Fail	Fail	Fail	Pass

CAPE SABLE SEASIDE SPARROW PROJECT REQUIREMENTS					
	Alternative Scores				
	Base Con-dition	Corps Preferred Alternative	Other Alternatives		
	Test 7 Phase 1	Alternative 5	Alternative 1	Alternative 6	RPA
PERFORMANCE MEASURES		Phase 1-IOP 2B*	ISOP 9dR	IOP 5a	RPA02
PRIORITY 1 PROJECT OBJECTIVES					
1-Evaluate Effects on Cape Sable Seaside Sparrow					
1A-Cape Sable Seaside Sparrow (Western Population)					
1A1-Nesting Habitat Availability	1	5	5	5	5
Objective Subtotal Mean Score	**1**	**5**	**5**	**5**	**5**
1B-Cape Sable Seaside Sparrow (Eastern Populations)					
1B1-Nesting Habitat Availability	1	1	1	1	5
1B2-Habitat Vegetation Maintenance	1	1	1	1	5
Objective Subtotal Mean Score	**1**	**1**	**1**	**1**	**5**

Table 5.16 cont.. Interim Operating Plan Performance Scores for Priority One and Two Objectives.

OTHER LISTED SPECIES-ALTERNATIVE SCORES					
	Alternative Scores				
	Base Condition	Corps Preferred Alternative	Other Alternatives		
	Test 7 Phase 1	Alternative 5	Alternative 1	Alternative 6	RPA
		Phase 1- IOP 2B*	ISOP 9dR	IOP 5a	RPA02
PRIORITY 2 PROJECT OBJECTIVES					
2-Evaluate Effects on other Listed Species					
2A-Wood Stork					
2A1-Flow Volume and Hydroperiod Reductions	1	1	1	1	1
Objective Subtotal Mean Score	1	1	1	1	1
2B-Snail Kite					
2B1-Habitat Suitability	5	1	1	1	5
Objective Subtotal Mean Score	5	1	1	1	5
2C-West-Indian Manatee					
2C1-North River Salinity Regimes	1	1	1	1	1
2C2-Shark Slough Flows	5	1	1	1	4
2C3-Taylor Sloughs Flows	5	2	4	2	1
2C4-Monthly Flow Distributions - Biscayne Bay	5	1	1	1	5
Objective Subtotal Mean Score	4	1	2	1	3
2D - American Crocodile					
2D1-North River Salinity Regimes	1	1	1	1	1
2D2-Shark Slough Flows	5	1	1	1	4
2D3-Taylor Sloughs Flows	5	2	4	2	1
2D4-Monthly Flow Distributions - Biscayne Bay	1	5	5	5	1
Objective Subtotal Mean Score	3	2	3	2	2

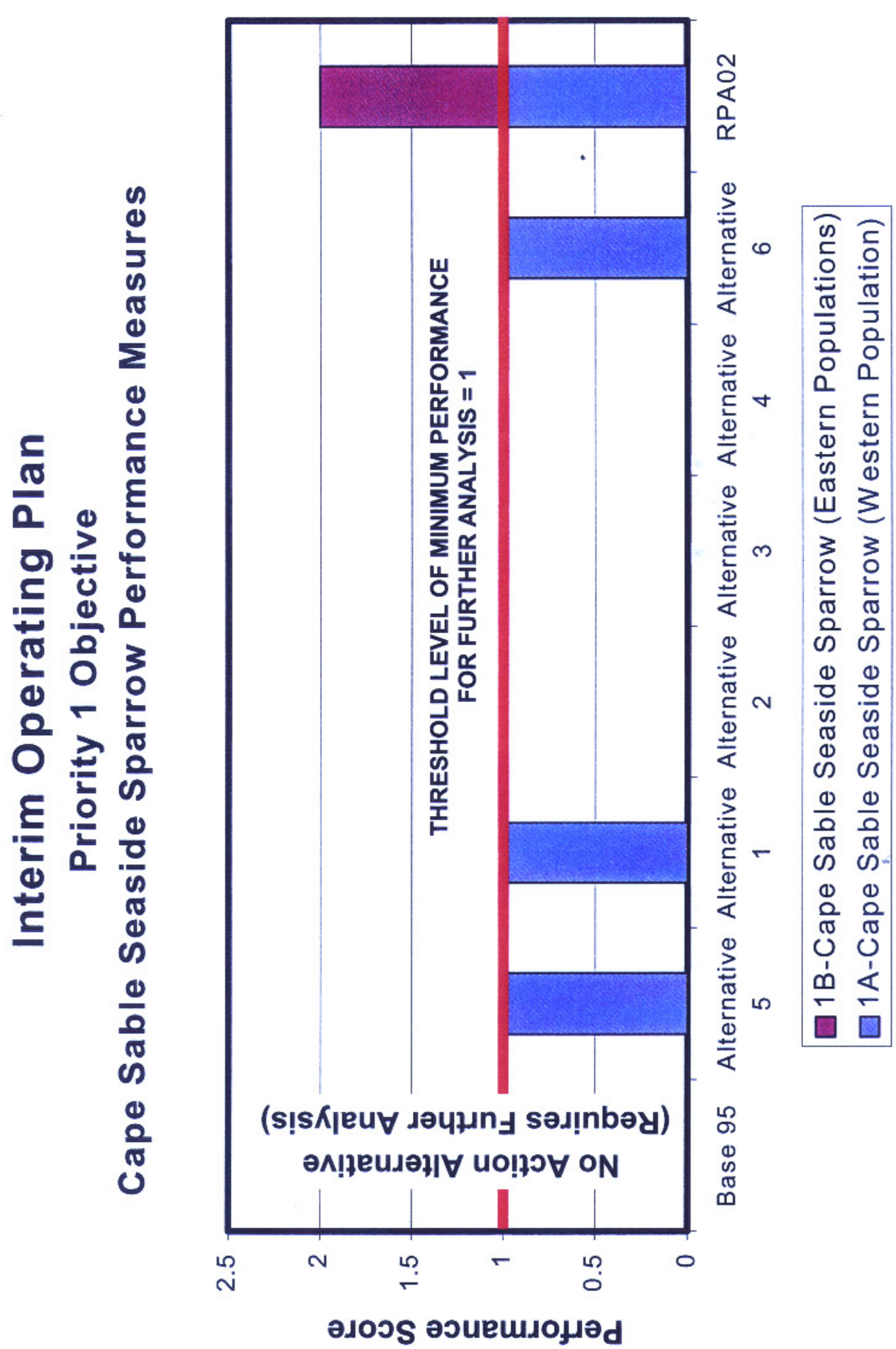


Figure 5.22. Aggregate measure of performance scores for Priority One Objectives, CSSS.

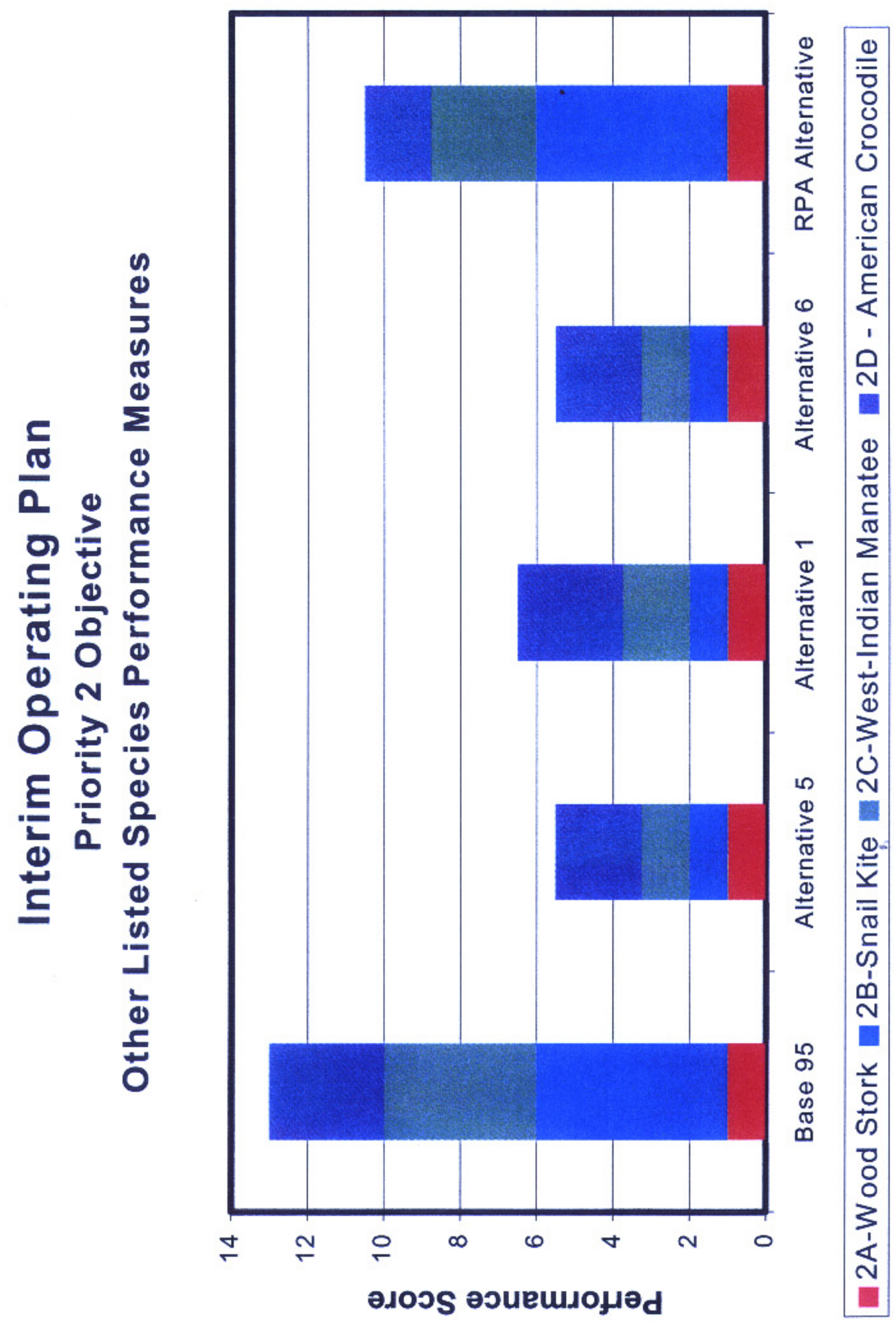


Figure 5.23. Aggregate measure of performance scores for Priority Two Objectives, Other Listed Species.

Literature Cited

Armentano, T.V., D.T. Jones, and B.W. Gamble. 2000. Recent patterns in the vegetation of Taylor Slough. Poster Abstract. Abstract Book for Greater Everglades Ecosystem Restoration (G.E.E.R.) Science Conference, December 11 – 15, 2000, Naples, FL. Page 187.

Bennetts, R.E. and W. M. Kitchens. 1997. The demography and movements of snail kites in Florida. Technical Report 56, USGS-BRD, Florida Cooperative Fish and Wildlife Research Unit, Gainesville, FL

Bennetts, R.E., W.M. Kitchens, and D.L. DeAngelis. 1998. Recovery of the snail kite in Florida: Beyond a reductionist paradigm. In Trans. 63rd No. Am. Wildl. and Natur. Resour. Conf.

C&SF Restudy. 1998. Florida Bay performance measures: Salinity in coastal basins estimated from upstream water stages. Draft documentation, 1998.

Curnutt, J. L., A. L. Mayer, T. M. Brooks, L. Manne, O. L. Bass Jr., D. M. Fleming, M.P. Nott and S. L. Pimm. 1998. Population dynamics of the endangered Cape Sable seaside-sparrow. Animal Conservation 1:11-21

Darby, P.C., P.L. Valentine Darby, R.E. Bennetts, J.D. Croop, H.F. Percival, and W.M. Kitchens. 1997. Ecological studies of apple snails (*Pomacea paludosa, say*). Technical report, Florida Cooperative Fish and Wildlife Research Unit, Gainesville, Florida. Final Report prepared for South Florida Water Management District and St. Johns River Water Management District, Contract #E-6609.

Lockwood, J.L., K.H. Fenn, J.L. Curnutt, D. Rosenthall, K.L. Balent, and A.L. Meyer. 1997. Life history of the endangered Cape Sable seaside sparrow. Wilson Bulletin, 109:702-731.

Ogden, J.C. 1998. Endangered species performance measures (wood stork). Document prepared as part of the Southern Everglades Restoration Alliance planning process, South Florida Water Management District, West Palm Beach, FL.

Pimm, S.L. 2000. The 2000 Cape Sable Seaside Sparrow Annual Report. Unpublished report. Columbia University, NY.

U.S. Fish and Wildlife Service. 1999. Multi-species recovery plan for the threatened and endangered species of south Florida, Volume 1 of 2, The Species, Vero Beach, FL.

Van Lent, T., R.W. Snow and F.E. James. 1999. An examination of the modified water deliveries project, the C-111 Project, and the experimental water deliveries project: hydrologic analyses and effects on endangered species. South Florida Natural Resources Center, Everglades Nat. Park, Florida.

Walters, J.R., S.R. Beissinger, J.W. Fitzpatrick, R. Greenberg, J.D. Nichols, H.R. Pulliam and D.W. Winkler. 1999. Cape Sable seaside sparrow Panel Review: Final Report. Miami, FL.

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Chapter 6- Hydrologic and Ecological Consequences in Other Natural Areas

6.1 Introduction

This chapter provides documentation of the hydrologic effects and possible ecological ramifications for other natural areas of the operational plans proposed. An examination of the effects from water management operations of the RPA and the "preferred plan" Alt5P1 for these areas is a reasonable requirement in assuring impacts are minimized to the extent practical. The areas that will be examined include the Loxahatchee National Wildlife Refuge, WCA-3A and WCA-3B, Shark Slough and estuaries of Florida Bay and Shark Slough. These areas and the relevant structural features of the C&SF Project discussed throughout this chapter are shown in **Figure 1.1** (Chapter 1). The importance of the analysis is two-fold. First, it provides the hydrologic framework for assessment of potential ecologic consequences of the proposed set of water management operations. Secondarily, by examining hydrologic metrics in the interior of these natural areas a more thorough understanding of the effects of a proposed operation or structural feature is possible. Therefore, without necessarily focusing on the specific operations or structural features implemented it is possible to gain insight into it's adequacy or failure in meeting stated objectives.

6.2 Loxahatchee National Wildlife Refuge

Hydrologic impacts from the implementation of RPA02, the "No Action" alternative (Alt1), Alt5P1 and Alt6P1 relative to EWDT71 are not expected in Loxahatchee National Wildlife Refuge because no changes to the regulation schedule are contemplated.

6.3 Water Conservation Area 2A

Adverse hydrologic impacts are not expected in WCA-2A if either RPA02, or IOP alternatives were implemented as proposed. It is important to note that the proposed operational plans would not prevent the excessive deep flooding and frequent overdrainage present during previous operational periods, thereby continuing the deterioration of the relatively few remaining tree islands and wetland areas. Overall, none of the proposed alternatives produce favorable hydrologic conditions suitable for foraging by wading birds across the range of observed rainfall conditions. Only during extreme dry periods ("1-in-10" to "1-in-20" year return intervals) would water depths be conducive to successful foraging. These observations are consistent with the hydrologic and ecologic conditions that have prevailed throughout WCA-2A, and given the similarity of the proposed alternatives with the base condition , they would be expected to continue unchanged.

Achieving and sustaining zero impacts noted for WCA-2A under all but the RPA02 operations relative to current conditions relies heavily on the conveyance of large flows to tide via the Hillsboro Canal. **Figure 6.1** shows the frequency of annual flows (in acre-feet), diverted to tide

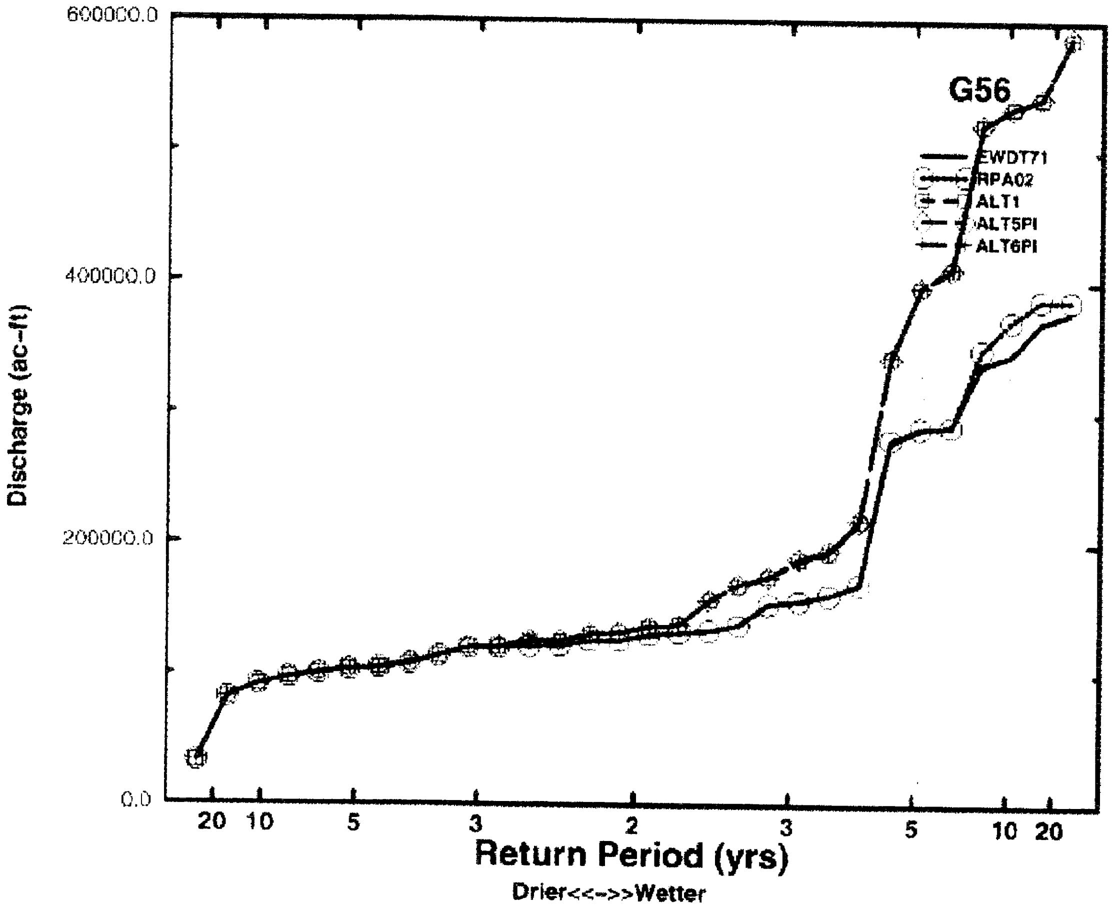


Figure 6.1. Frequency of annual flows to Lake Worth Lagoon and tide, in acre-feet via G-56.

through G-56 simulated for base conditions and proposed alternatives. Under Alt1, Alt5P1 and Alt6P1, during wetter periods large increases beyond the base conditions would occur. During these wetter periods diversions to tide of approximately 150,000 to 200,000 acre-feet could be expected. The size of these discharges during the highest rainfall periods raises serious question with respect to their actual implementation.

6.4 Water Conservation Area 2B

Adverse hydrologic impacts are not expected in Water Conservation Area 2B if any of the alternatives were implemented as proposed.

6.5 Water Conservation Area 3A

The area of WCA-3A requires that the analysis of this region be undertaken in sections which we define as northwestern, central and southern. The hydrologic effects of all of the proposed alternatives, relative to RPA02 and EWDT71 simulations, are very small in northwestern WCA-3A. Peak water levels in IR 20, shown in **Figure 6.2** are very similar for all simulations. Estimated annual peak water levels differ minimally occurring only in the extreme wet periods. During these very wet periods, the RPA, Alt1, Alt5P1 and Alt6P1 produces lightly higher peak depths than EWDT71 of about 0.2 feet maximum. The slightly increased depths have only a minimal impact on hydroperiods. **Figure 6.3** shows that hydroperiods at 0.5 feet of ponding are identical for nearly all simulations. This suggests that, for northwestern WCA-3A, the regulation schedule deviation will not have impact. Moreover, closure of the S-12, S-343 and S-344 structures in the RPA, all of the alternative simulations have no observable effect in this area. However, during extremely wet years, the combined restriction on the S-12 structures and S-333 or the November closure of S-12A and the S-343 and S-344 structures could result in a small increase in peak water levels.

Central WCA-3A shows no significant changes related both the WCA-3A regulation schedule modifications or those to S-12, S-343 and S-344 operations. **Figure 6.4** indicates that nominal increases (0.1-0.2 feet.) in annual maximum water levels for all alternatives relatives to EWDT71 could occur in IR 18, located south of Alligator Alley in central WCA-3A, during the wettest periods simulated. Similar increases, of the same magnitude are observed between RPA02 and the proposed plans and EWDT71 during "1-in-3" to "1-in-5" wet periods. While the observed differences seem minor, it is important to note that their avoidance requires routing of WCA-3A excess flood waters to the SDCS utilizing either S-151/L-30 or S-333/S-334 options. The proposed operations to achieve these effects becomes a concern when the volumes routed to the SDCS and eastern sub-populations are examined.

Figure's 6.5 and 6.6 shows the increase in annual flows that will result from the routing of WCA-3A regulatory flows to the SDCS under the proposed plans.

The significance of the diversion of regulatory flows becomes more evident observing inundation durations further south in WCA-3A. **Figures 6.7** is a frequency plot of inundation durations at 2.0 feet of ponding for IR 17. RPA02 increases the number of days when water levels exceed 2.0 feet by about 30 days during the "1-in-3" dry to "1-in-3" wet year events, relative to EWDT71. The proposed plans during the same periods would increase water levels above 2.0 feet by approximately half that of RPA02 or 15 days. However, in the most extreme events, differences between RPA02, the proposed plans, and EWDT71 could be considered minimal or non-existent. This suggests that restricting S-12, S-343, and S-344 discharges will likely increase durations of inundation at depths greater than 2.0 feet during wetter than normal conditions, relative to EWDT71. Mitigation of the effects of early closures are to an extent accomplished by the routing of WCA-3A regulatory flows to the SDCS. The magnitude of such operations during the wetter rainfall periods simulated seems to at a minimum create a concern of increased risk to downstream basins.

The southern pool of WCA-3A, represented by IR 14, shows more significant differences between alternatives than in either central or northern WCA-3A. Peak water levels, shown in

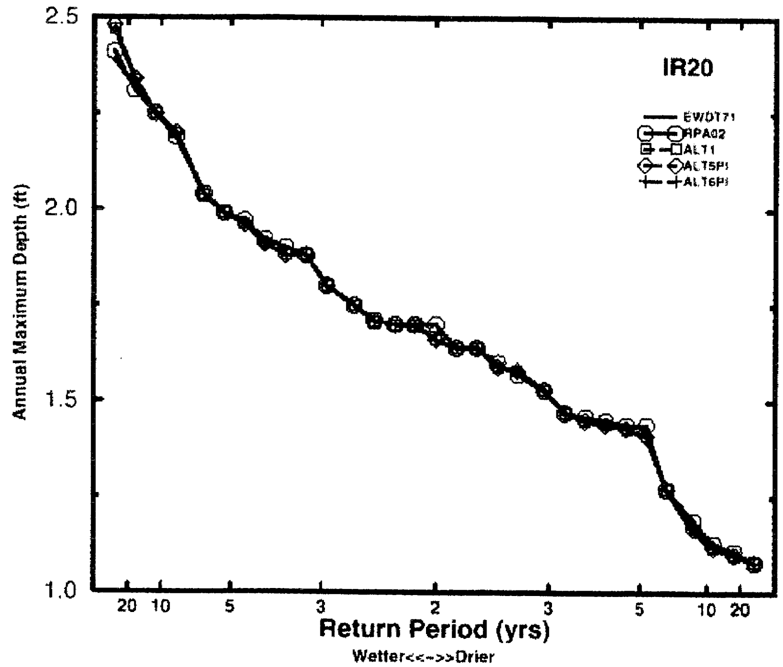


Figure 6.2. Annual maximum water depths for Indicator Region 20.

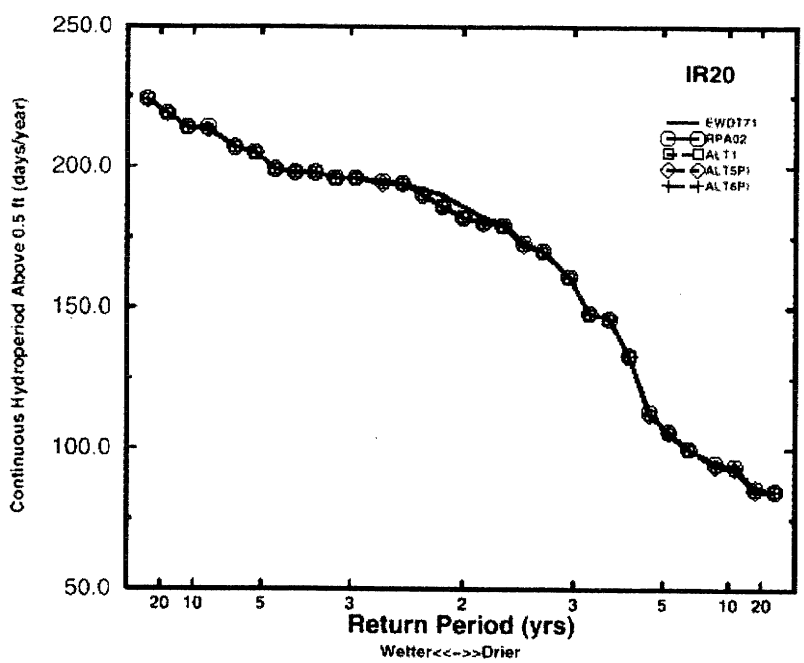


Figure 6.3. Continuous hydroperiod of water depth equal or greater than 0.5 feet for Indicator Region 20.

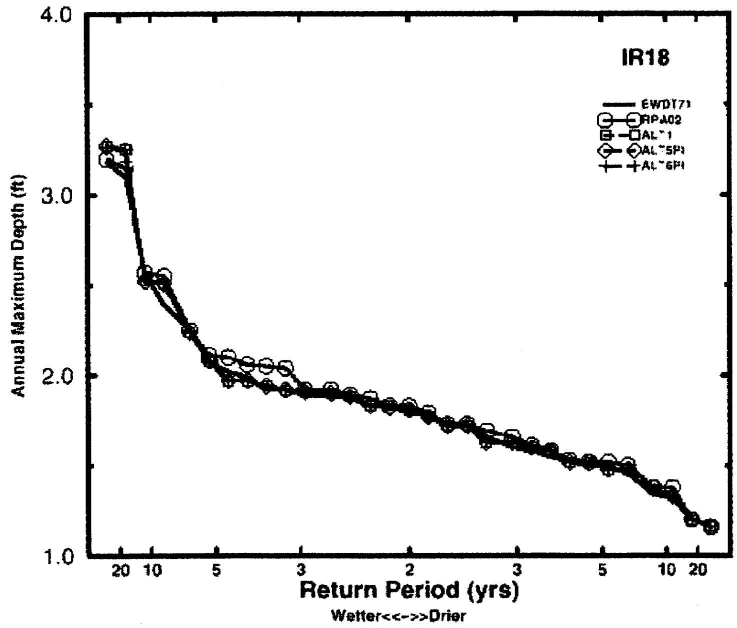


Figure 6.4. Annual maximum water depths for Indicator Region 18.

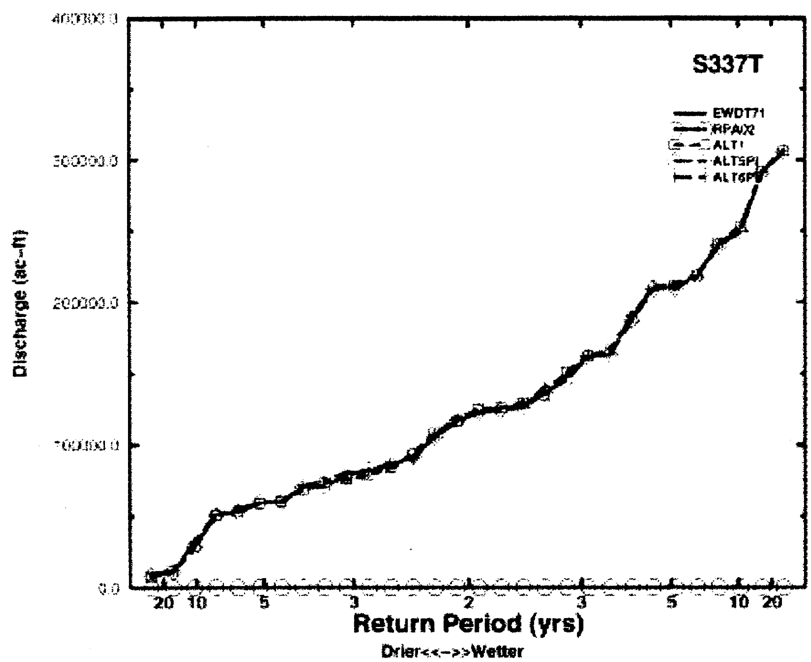


Figure 6.5. Frequency of annual flows to the SDCS via L-30 and L-31N, in acre-feet, as measured at S-337.

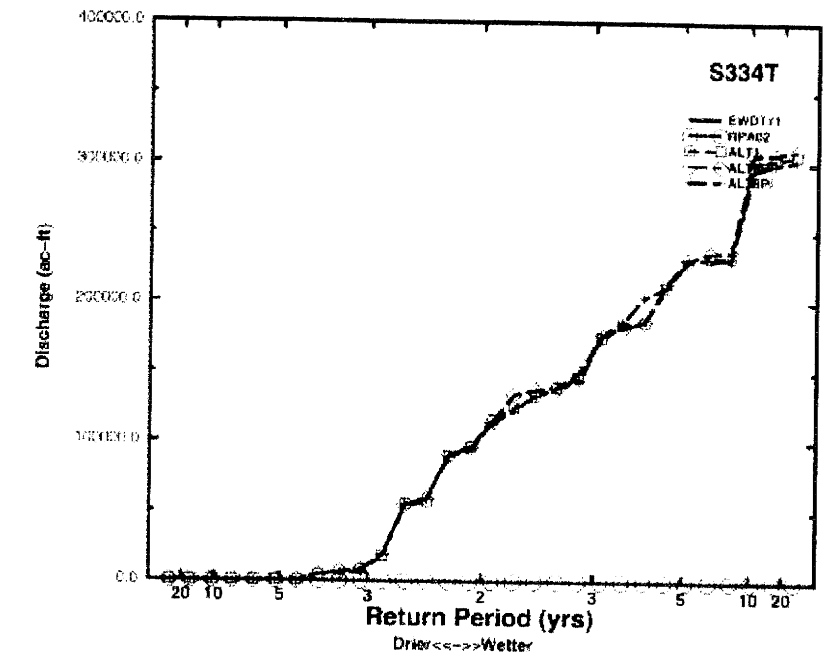


Figure 6.6. Frequency of annual flows to the SDCS via L-30 and L-31N, in acre-feet, as measured at S-334.

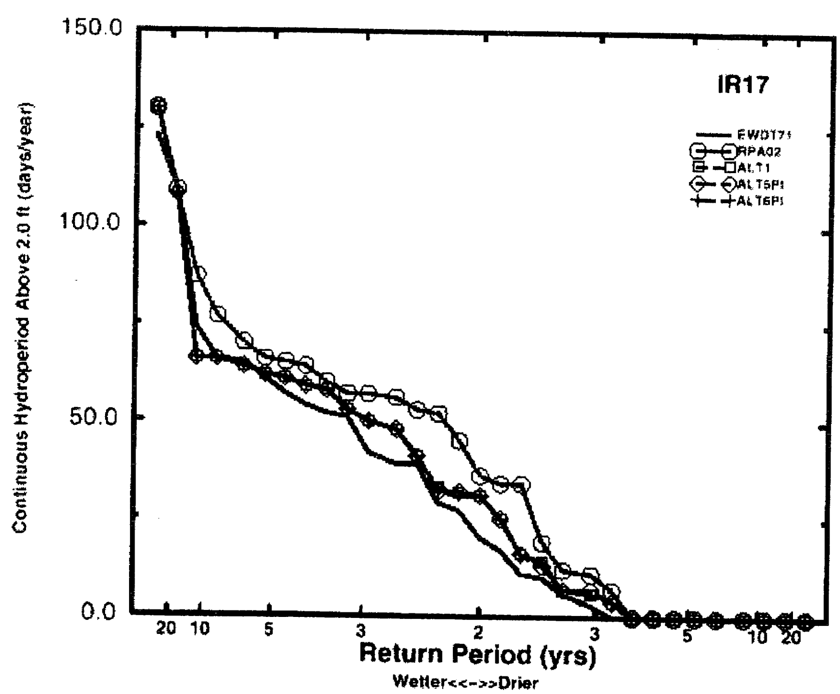


Figure 6.7. Continuous hydroperiod of water depth equal or greater than 2.0 feet for Indicator Region 17.

Figure 6.8 are expected to increase about 0.2 feet in RPA02, relative to EWDT71 and the proposed plans, during wetter than normal years. The increase in the peak stage in the southern pool of WCA-3A does not translate into a significant increase in the duration of ponding

Figure 6.9 shows the frequency of duration of inundation at depths of greater than 2.0 feet in IR14. Important to note first, is routing of WCA-3A regulatory flows to tide and the SDCS will most likely not prevent the undesirable occurrence of longer duration deeper inundation during the wettest periods simulated for all alternatives. During the "1-in-20" year events, all alternatives have 365 days, compared to about 220 days under EWDT71. Again these consequences are associated with the WCA-3A deviation schedule in combination with early S-12, S-343 and S-344 closures. In typical to slightly above normal rainfall years, lower durations are observed for Alt1, Alt5P1 and Alt6P1 than either EWDT71 or RPA. These 25 to 50 day decreases observed in the duration of deeper ponding during normal years for these alternatives corresponds to a significant reduction in durations of ponding exceeding 1.5 feet. **Figure 6.10** indicates that the operations associated with the routing of WCA-3A regulatory flows to the SDCS would likely promote drainage of the southern WCA-3A pool. Except for the RPA, each of the proposed plans would produce less frequent longer duration of inundation exceeding 1.5 feet than EWDT71 across the range of rainfall conditions simulated. The greatest of these differences could be expected from "1-in-3" to "1-in-10" wet year rainfall.

Overall, the simulated operations proposed indicate that water levels in the southern pool of WCA-3A would most likely be affected more than other areas of WCA-3A. Water levels in the pool appear most sensitive to operations for routing WCA-3A regulatory flows to the SDCS in the Alt1, Alt5P1 and Alt6P1 alternatives. However, during the wettest climatic conditions simulated it appears that closure of the S-12, S-343 and S-344 structures has the potential to significantly increase the ponding durations at depths of 2.0 feet and greater. A possible solution for avoiding these undesirable events during the extreme wet years can be visualized from examination of **Figure 6.11.** During extreme wet conditions, there is a 300,000 acre-feet reduction in S-12 discharges from EWDT71 levels in all alternatives. This reduction plus the WCA regulatory flows routed to tide and the SDCS **(Figure's 6.1, 6.5 and 6.6)** suggest additional outlet capacity is necessary unless inflows to WCA-3A from the Everglades Agricultural Area are reduced. If Everglades Agricultural Area inflow cannot be reduced, additional flows to WCA-3B and NESS could help reduce extreme highs in WCA-3A.

6.5.1 Tree Islands and Other Vegetation

The height of a tree island above the marsh surface determines its response to marsh water levels. Thus protracted periods with surface water exceeding depths of 2.5 feet are likely to exert flooding stress effects (ranging from replacement of existing species by more flood tolerant species to increased tree mortality without replacement) on those tree island hammocks having elevations less than 2.5 feet if the duration of flooding at that depth exceeds a month or two, but tree islands higher in elevation above the marsh surface might be unaffected depending on depth of the water and duration of inundation. Tree island communities consisting of species adapted to saturated soils (i.e., bayswamps or bayheads) would not be adversely affected by

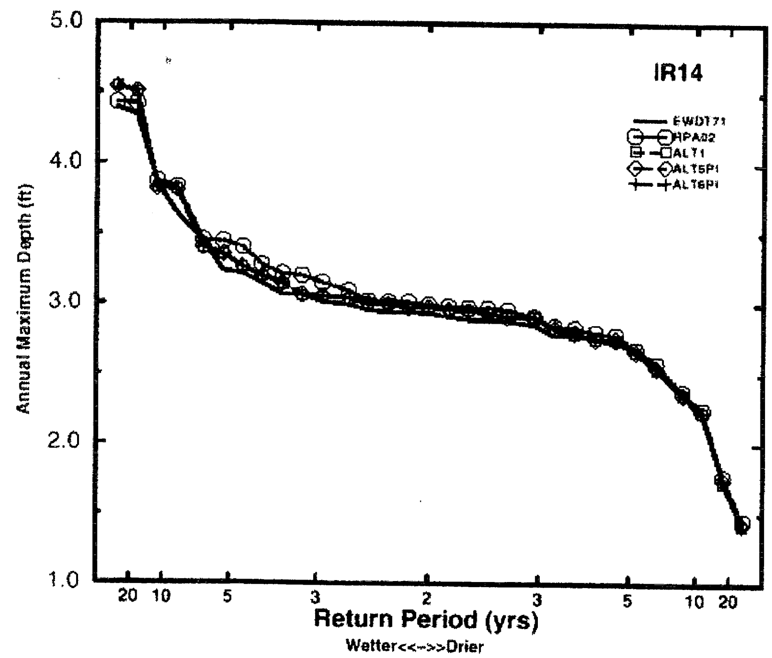


Figure 6.8. Annual maximum water depths for Indicator Region 14.

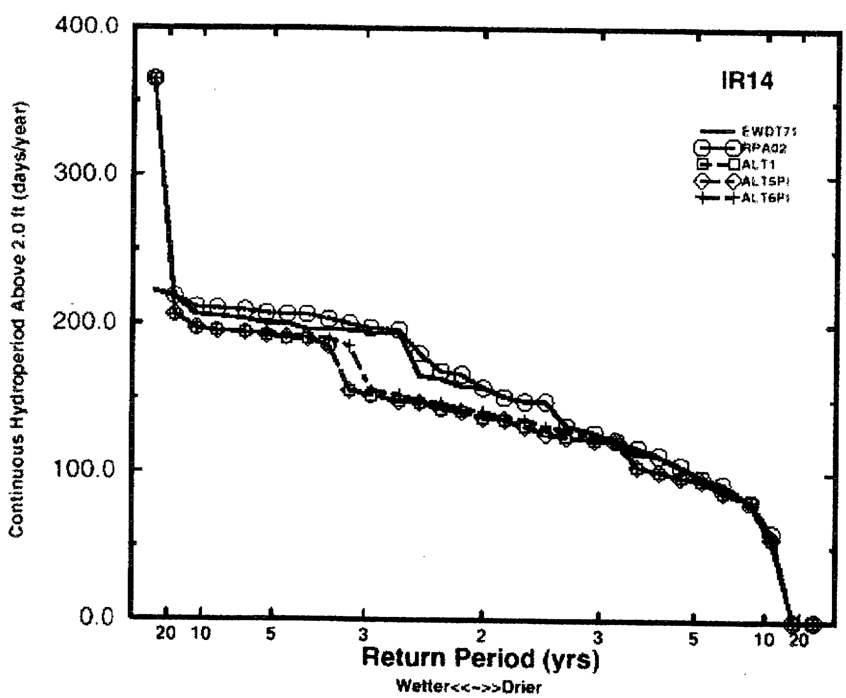


Figure 6.9. Continuous hydroperiod of water depth equal or greater than 2.0 feet in Indicator Region 14.

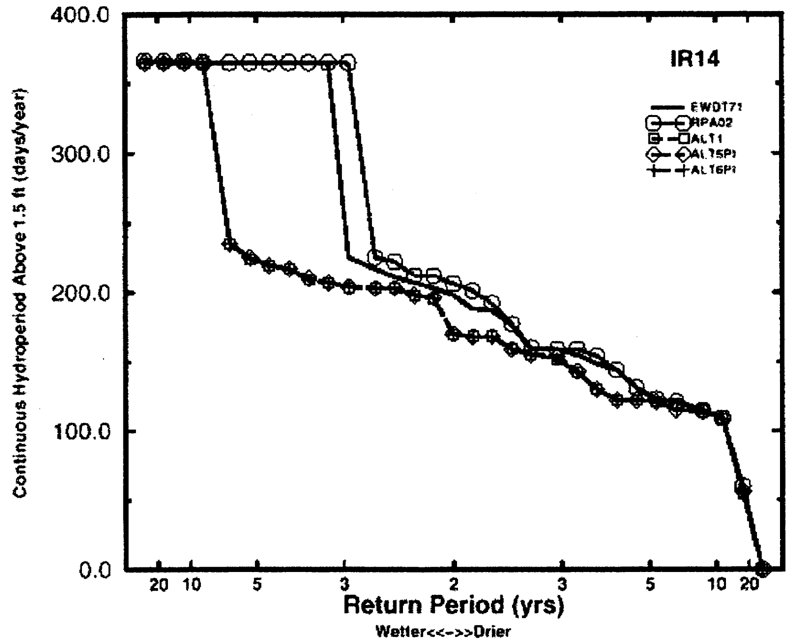


Figure 6.10. Continuous hydroperiod of water depth equal or greater than 1.5 feet in Indicator Region 14.

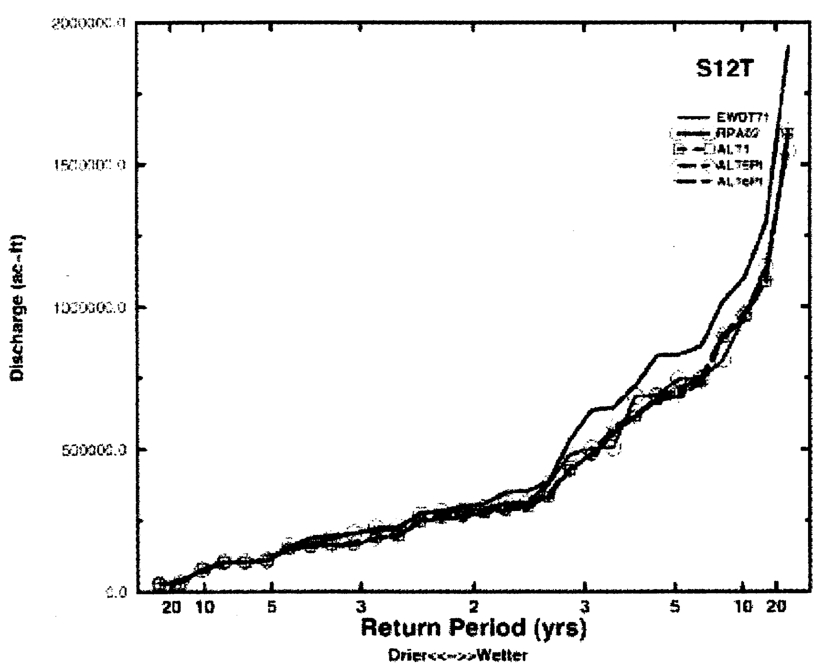


Figure 6.11. Total S-12 annual discharge, in thousands of acre-feet.

flooding at depths and durations that would affect hammocks. In central WCA-3A where many tree islands were damaged or destroyed by fires in the past, the remaining tree islands would be exposed to about one month of water levels greater than 2 feet deep under the RPA compared to 20 days in EWDT71 under average rainfall conditions **(Figure 6.12)**. The other alternatives fall in between, underscoring that differences among alternatives are small during average rainfall conditions. Furthermore, no depths exceed 2.5 feet under any alternative in average conditions. For "1-in 10" wet year, the difference in the duration exceeding 2.0 feet between the RPA and EWDT71 is about two weeks and between the RPA and the other alternatives, three weeks. There is no difference between any of the alternatives or the base in the duration of water >2.5 feet- namely about 40 days in "1-in-10" wet conditions. In moderately wet years, water depths would be 0.1 inch deeper in the RPA, a very small difference that may be impossible to ecologically distinguish in terms of effects upon slough vegetation development, fish productivity or long-term tree island impacts. Thus no additive stress can be linked to any of the alternatives, including the RPA **(Figure 6.12)**. Similarly, the hydroperiods suggest that during droughts there is no increased risk of fire associated with any of the alternatives compared to the base.

In southern WCA-3A, the duration of deep water simulated for all alternatives relative to EWDT71, shown in **Figure 6.13** suggest differences not exceeding 10 days under average conditions but rising to 45 days in 1 in 3 wet conditions. However the RPA would not increase water depths over the EWDT71 levels, and differences among all alternatives and the base falls to only a few days difference in the duration of depths exceeding 2.0 feet in all wetter periods and in droughts. Thus in very wet periods, neither the RPA or proposed alternatives would add to the deep water stress affecting tree islands. During "1-in-5" wet periods all alternatives would extend the periods when water depths exceed 2.5 feet by approximately 2-3 weeks. Similarly, compared to EWDT71, none of the alternatives can be distinguished in terms of a differential impact on the potential for development of slough vegetation which requires extended deep water. However, in moderately wet conditions, Alt1, Alt5P1, and Alt6P1 pull water down below both the 1 foot and 1.5 feet levels (the latter for 4 months longer than EWDT71) - an undesirable condition because it approaches the water levels that become insufficient for species needing long-term deep water needed such as large-mouthed bass and Florida gar.

6.5.2 Water Quality

Figure 6.14 evaluates the relationship between water depth continuously below the surface for 30 days in IR 18 in northern WCA-3A. It shows no difference between the different alternatives. However, **Figure 6.14** showing the same metric for IR 17 in central WCA-3A does show slight differences between the Alternatives. Alternative RPA02 performs the best with IOP Alt's performing the worst. EWDT71 performs slightly worse than Alternative RPA02 but better than the rest of the Alternatives (Alt1, Alt5P1, and Alt6P1).

6.6 Water Conservation Area 3B

Integrating the S-355s with the specified operations in **Table 4.1-4.7** appears to have resulted in significant changes to hydroperiods in WCA-3B. This effect would be exacerbated by actual S-

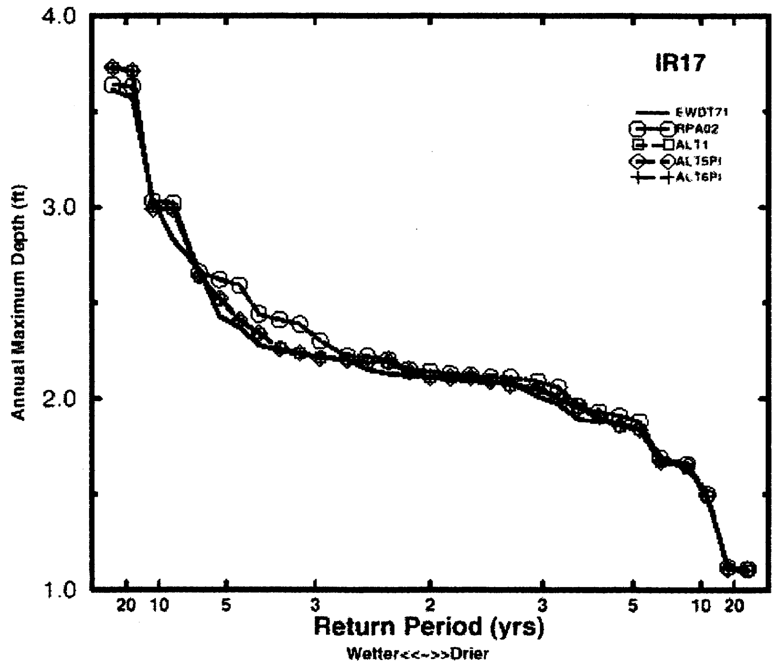


Figure 6.12. Annual maximum water depths for Indicator Region 17.

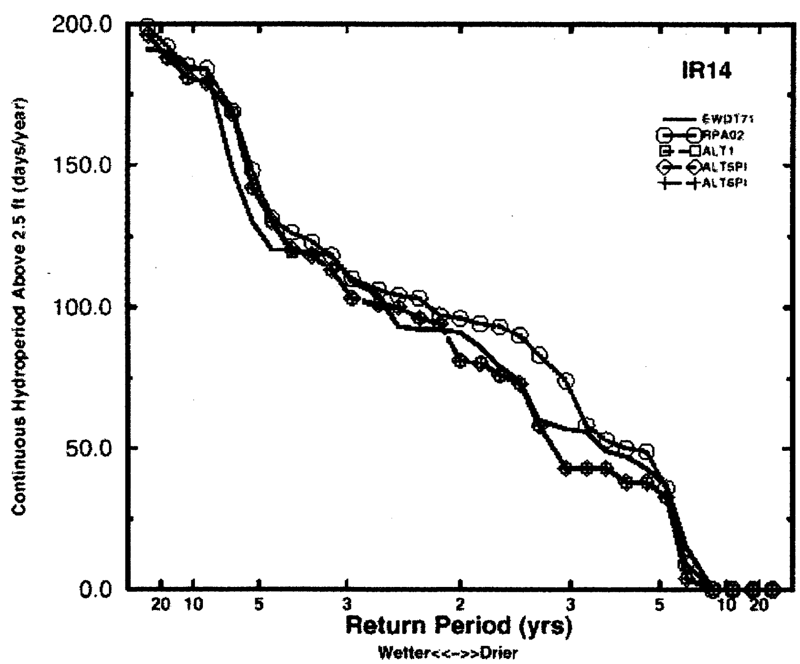


Figure 6.13. Continuous hydroperiod of water depth equal or greater than 2.5 feet in Indicator Region 14.

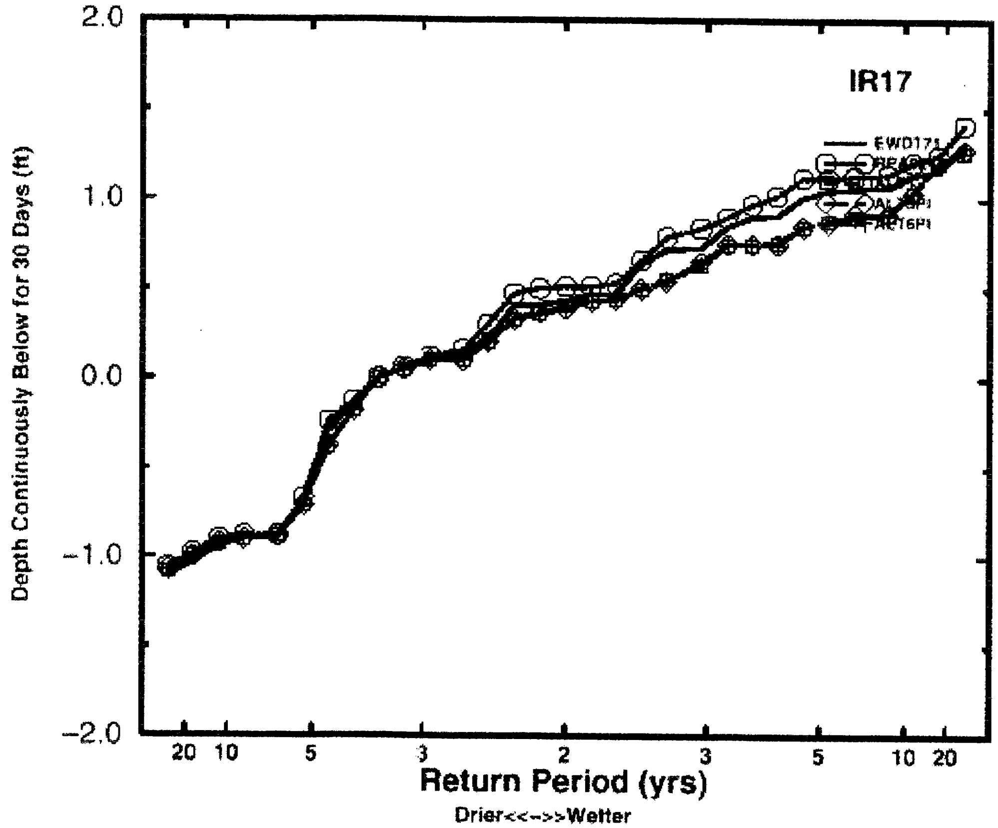


Figure 6.14. Minimum water depth water exceeded continuously for 30 days for Indicator Region 17.

335 operations that were not included in these SFWMM results, but would be implemented under the IOP Alternatives. In IR 15 under any of the scenarios, the inundation lengths at ponding depths above 1.0 feet are expected to decrease. **Figure 6.15** shows that the Alt1, Alt5P1 and Alt6P1 relative to EWDT71 all decrease from 1 to 3 months of ponding depths greater than 1.0 feet during average to wetter rainfall years. For this metric differences between the RPA and EWDT71 tend to be less than 1 month over much of the rainfall conditions simulated but does increase to 3 months for the wetter rainfall periods. From average to "1-in-5" year dry decreases of 1 to 2 months could be expected to occur, with less of an effect for this metric under the RPA than the other alternatives.

The large differences observed in **Figure 6.15** between the alternatives and the RPA and EWDT71 result from the change the frequency of water levels above 8.5 feet msl. **Figure 6.16** show that all alternatives with the exception of the RPA relative to EWDT71 have uniformly lower peak water levels. Explanation for the differences in stage and duration of ponding depths above 1.0 feet are not straightforward. However, it is ultimately related to the differences between the water management operations of S-333, S-355 and S-334 in the RPA and the proposed alternatives.

The differences observed in hydroperiods for IR 15 shown in **Figure 6.15** are also found in IR 16 when water depths exceed 2.0 feet and only occur under very wet conditions **(see Figure 6.17)**. Decreases in the durations of very deep water events during these periods is less than a month in a half for the Alt1, Alt5P1 and Alt6P1 relative to EWDT71. The RPA follows EWDT71 for this metric with the exception of during the wettest periods when increased durations of 1 month and a half are observed. Surface water drawdowns that bring water levels below ground surface occur in all alternatives during average and dry year periods. Dry periods last for approximately 1 month in an average year and increasing to 5 months in "1-in-10" dry intervals.

The observed increase and decreases in stage and hydroperiod metrics for the alternatives in WCA-3B can be attributed to a number of factors chiefly the combination of operations effecting inflows and outflows via S-355. A secondary factor to consider is the consequences of S-333 and S-334 operations in routing WCA-3A regulatory flows to the SDCS on stages in L-29 and Northeast Shark Slough. **Figure 6.19** shows the frequency of annual change in WCA-3B storage resulting solely from structural inflows (S-151 minus S-31 plus S-337) and outflows (S-355). Because WCA-3B's area is approximately 98,300 acres metrics readily reflect an increase of 100,000 acre-feet in the RPA during "1-in-10" year wet conditions. The fact that S-355 outflows are in excess of inflows to WCA-3B under "1-in-3" year droughts to extreme drought conditions are primarily responsible for the differences observed between the Alt1, Alt5P1 And Alt6P1 and EWDT71. Again, this would be exacerbated by actual S-335 operations not included in the modeling.

Decreases in water levels including their duration in WCA-3B are also a result of seepage both to its east and south. In general, in the modeling L-30 stages remain constant for all alternatives throughout the simulation period. However, the same is not true for L-29 to the south. **Figure 6.20** shows daily stage duration curves for each of the alternatives. Increased RPA stages during the wetter periods result in decreased S-355 flows and subsequently the decreased available storage observed in **Figure 6.16**.

Maintenance of the lower stages in the Alt1, Alt5P1 and Alt6P1 relative to EWDT71, during the same periods yields higher S-355 discharges corresponding to the increased available storage in WCA-3B. These lower L-29 stages result primarily from the wet season constraints on S-333 flows in combination with S-334 routing of WCA-3A regulatory flows to the SDCS.

6.6.1 Tree Islands and Slough Ecosystems

Generally in terms of ecological effects, differences among alternatives and the base are small particularly under average and dry conditions. But under wetter than normal conditions, the RPA increases periods of deeper water somewhat over the base condition, a small benefit, while the other alternatives decrease the duration of deeper water inundations, a disadvantage in

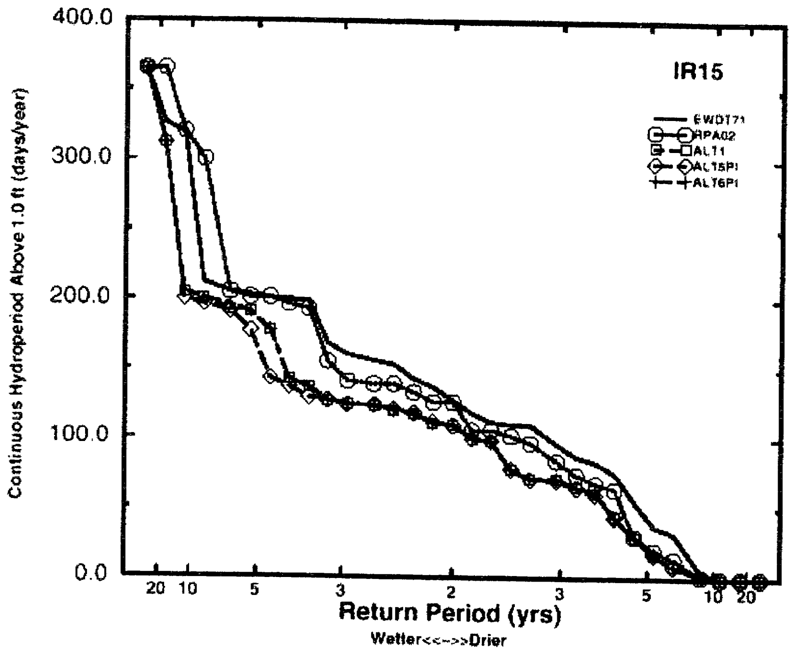


Figure 6.15. Continuous hydroperiod of water depth equal or greater than 1.0 feet for Indicator Region 15.

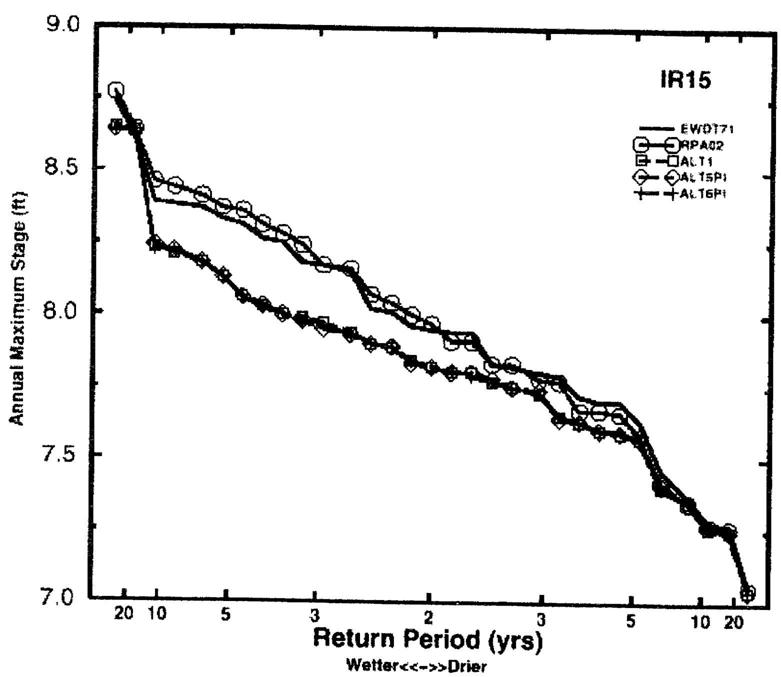


Figure 6.16. Annual maximum stage for Indicator Region 15.

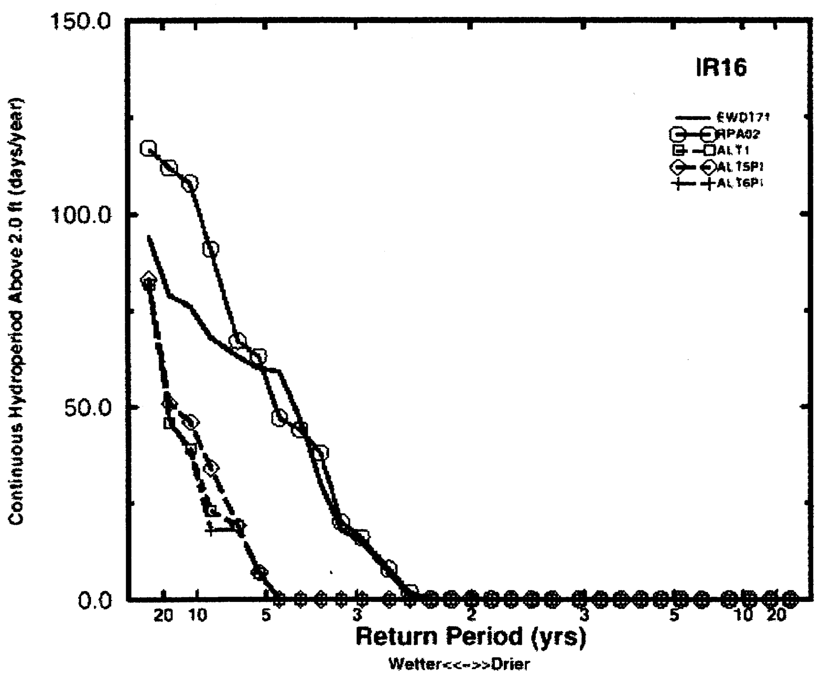


Figure 6.17. Continuous hydroperiod of water depth 'equal or greater than 2.0 feet for Indicator Region 16.

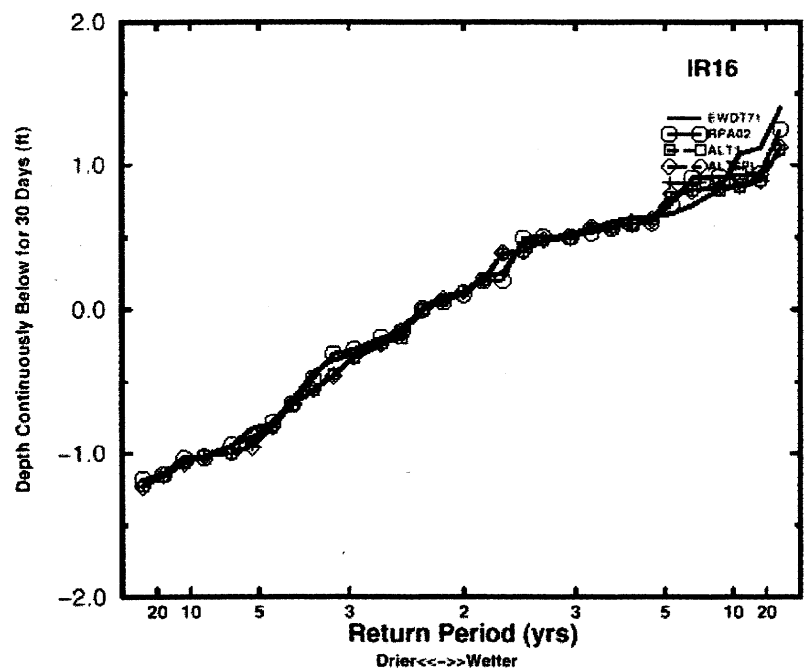


Figure 6.18. Minimum water depth exceeded continuously for 30 days for Indicator Region 16.

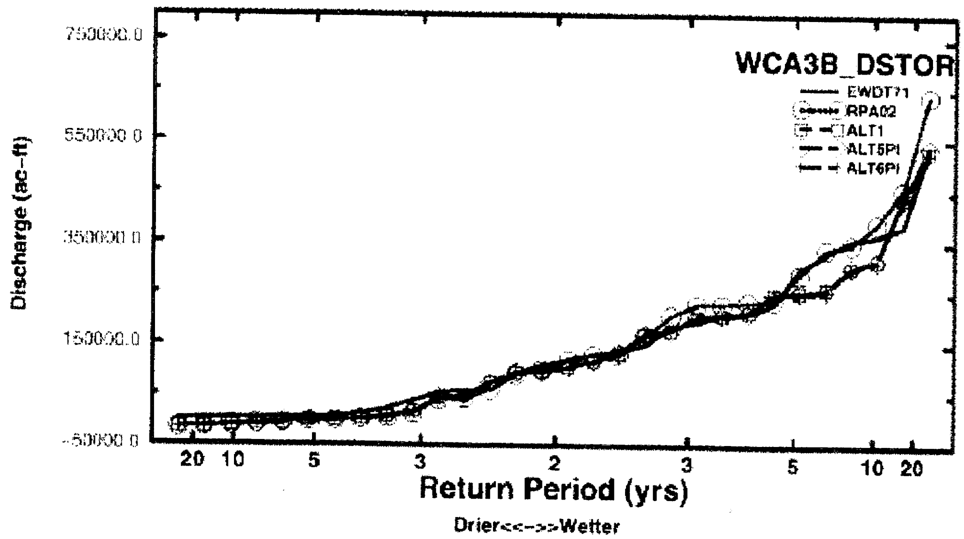


Figure 6.19. Frequency of annual flows to the SDCS via L-30 and L-31N, in acre-feet.

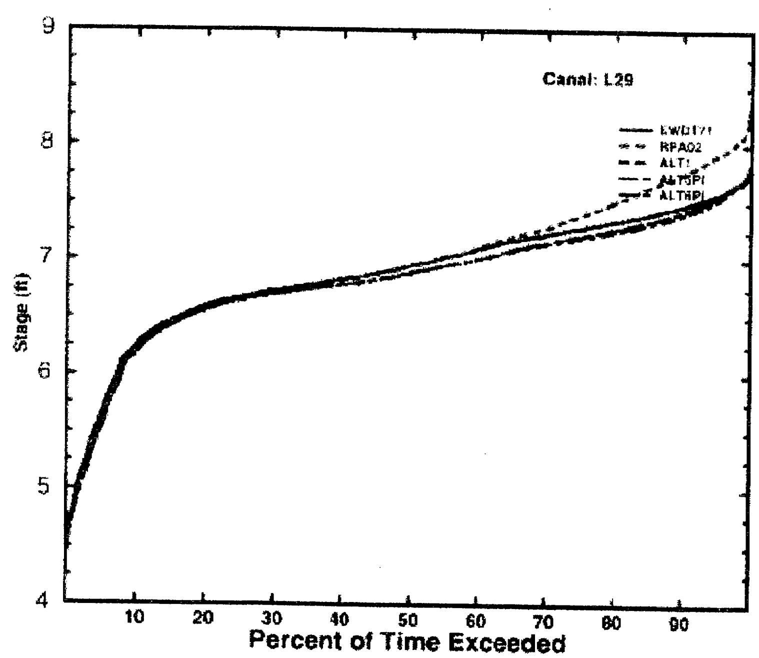


Figure 6.20. Daily stage duration curve (feet) for L-29 canal.

WCA-3B, an area formerly part of the deep flowing water slough system that is now subject to reduced inflows and low water levels. **(Figure 6.15)**. Thus both slough vegetation development with its associated peat accretion as well as productivity of large fish are likely to have been impeded by the depressed water levels in 3B, and this trend would be accelerated under alternatives 1, 5 and 6. In "1-in-10" wet years, continuous depths exceeding 1 feet decrease from about 10 to 11 months under both the base and RPA to 6 to 7 months for the other alternatives, the latter being a duration far too short for a functional slough community. The differences in duration of inundation at 1 feet and above appear diminished in very wet years. Water depths exceeding two feet only occur in extremely wet years and even then stay below 2.5 feet, a typical slough depth in the natural system. The RPA provides a small increment of additional water that moves in a desirable direction in terms of slough community (animal and plant) development without imposing stress on tree islands. **(Figure 6.16),** At the other extreme, differences among the base and all alternatives during dry years is minor and distinguishing fire risk unwarranted.

6.6.2 Water Quality

Figure 6.18 evaluates the relationship between water depth continuously below the surface for 30 days in IR 16 in WCA-3B. 95 Base and Alternative RPA02 performed the best with alternatives Alt1 following the two best. Figure IR16 showing the same metric for IR 16 in eastern WCA-3B shows much the same performance. 95 Base and RPA02 perform the best and the other three alternatives (Alt1, Alt5P1 and Alt6P1) perform similarly between the two extremes.

6.7 Shark Slough

6.7.1 Northeast Shark Slough

NESS water levels and hydroperiods are affected by a number of parameters in these alternatives. The alternatives vary the surface water inflows from S-333 and S-355 via L-29 borrow canal, surface water outflows from S-334, the canal stage in L-31N along the area's east side, and the degree of S-332B pumping onto the adjacent marl prairies of the Rocky Glades. Additionally, inflows and outflows are highly regulated by constraints on stage of the L-29 canal and at G-3272 **(see Figure 1.1, Chapter 1).** The net effect on NESS hydrology depends to one degree or another upon all of these variables

In terms of peak water levels, the Alt1, Alt5P1 and Alt6P1 are almost identical to EWDT71 **(see Figure 6.21)**. The RPA shows significantly higher water level peaks, with increases of ranging from 0.3 feet in a "1-in-3" drought to 1.0 feet in "1-in-10" wet years. The former noted alternatives while having increased discharges into NESS via L-29 borrow canal relative to the EWDT71 occur primarily in the dry season due to the constraints noted. The RPA with no constraints, other than capacity of S-333 results in much higher flows to NESS not only annually but also in the wet season consistent with the natural occurrence of rainfall.

Figure's 6.22 and 6.23 show the frequency of dry and wet season flows to NESS, respectively. Dry season differences between all the alternatives and EWDT71 are from less than 25,000 to

175,000 acre-feet. Each of the alternatives predicts decreased dry season flows relative to EWDT71 during the driest periods. During average rainfall to "1-in-5" wet year rainfall RPA dry season flows range to 50,000 acre-feet less that EWDT71 while the other alternatives range to 50,000 acre-feet more than predicted by EWDT71. During the wettest rainfall periods dry season flows to NESS in all alternatives exceed those predicted by EWDT71 by 90,000 to 175,000 acre-feet, the Alt1, Alt5P1 and Alt6P1, and the RPA respectively. **Figure 6.23** indicates that from the "1-in-3" dry year to the wettest periods simulated the RPA shows a marked increase of flows to NESS ranging from 25,000 to 100,000 acre-feet over all other alternatives including EWDT71. Combined the net result is an increase in annual flows to NESS in the RPA over all other alternatives of 50,000 to 200,000 acre-feet during wetter rainfall periods. This information underlines the importance of achieving peak wet season flows in coincidence with peak annual rainfall in contributing to the desirable peaks observed in **Figure 6.21**.

The significance of these flows evident in peak annual stage is not immediately evident in an examination of hydroperiods. Consider first hydroperiods at depths greater than 1.0 feet **(Figure 6.24)**. During all but the wettest years, hydroperiods at depths of greater than 1.0 feet would be expected to increase significantly for the RPA relative to EWDT71. Decreased duration of depths of greater than 1.0 feet for the other alternatives relative to EWDT71 is also unexpected, despite the similarity in the annual peaks. The explanation is the relationship between the seasonal introduction of surface water inflows to NESS depicted in **Figure's 6.22 and 6.23.**

6.7.1.1 Tree Islands and other Vegetation

Pronounced differences in the maximum water depths and the duration of inundation above 1.5 feet make the RPA alternative clearly preferable in terms of advancing towards restoration of this slough community. **(Figures 6.25)**. The overdry conditions found in the base - i.e., essentially at no time with water above 1.5 feet in dry and average conditions and no more than a month even in very wet conditions- would be perpetuated in Alternatives 1, 5 and 6, all of which would closely resemble the base condition. The RPA significantly improves this situation in average and moderately wet years when peak annual depths increase. Although these values still leave depths lower than probable natural slough conditions, they represent real improvement, particularly in the duration of water exceeding 1.5 feet. Here for example, in a "1-in-10" year wet year, the continuous duration of water more than 1.5 feet deep is 140 days in the RPA but only 15 days in the other alternatives and the base. Even the water levels under RPA assumptions are too shallow for a functional slough community and no water depth under any alternative or the base reaches 2.5 feet even under extremely wet conditions- a shortcoming that reduces the early dry flows in the sloughs and estuaries that are essential for consumers such as wading birds and fish and for moderating dry season salinity levels in the northern and Gulf Coast embayments. Furthermore, because of depressed water levels, fire vulnerability would increase markedly under all alternatives, as indicated by the predicted water table withdrawals below -1.5 feet in all years drier than the "1-in-5" year condition.

In average rainfall years to extreme droughts, there would be long periods without surface water ranging from 50 to 200 days in all alternatives and the base. This presents too dry a condition for

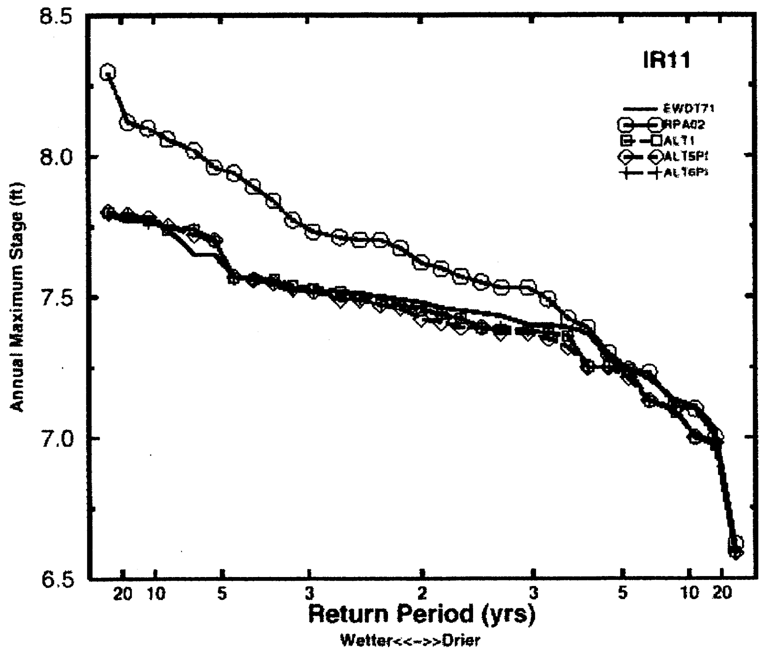


Figure 6.21. Annual maximum water depths for Indicator Region 11.

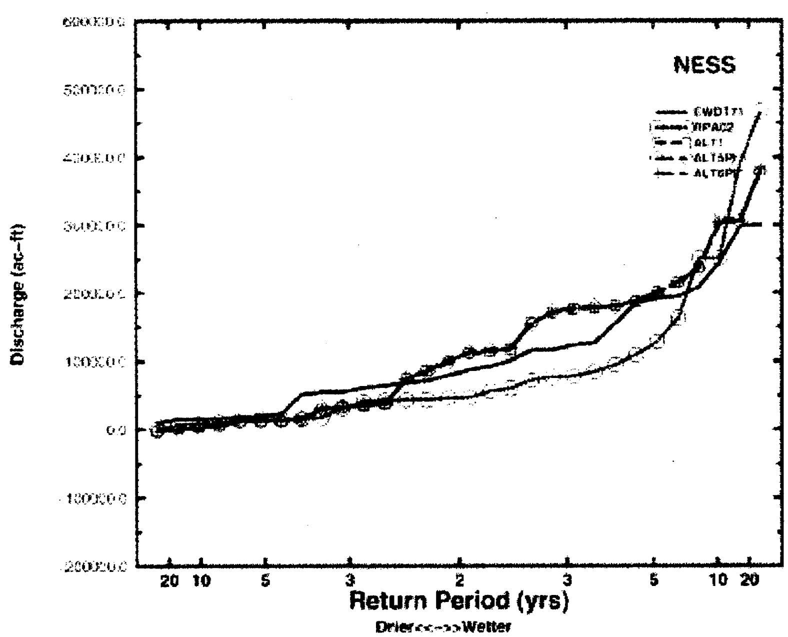


Figure 6.22. Frequency of dry season flows, in acre-feet to the Northeast Shark Slough.

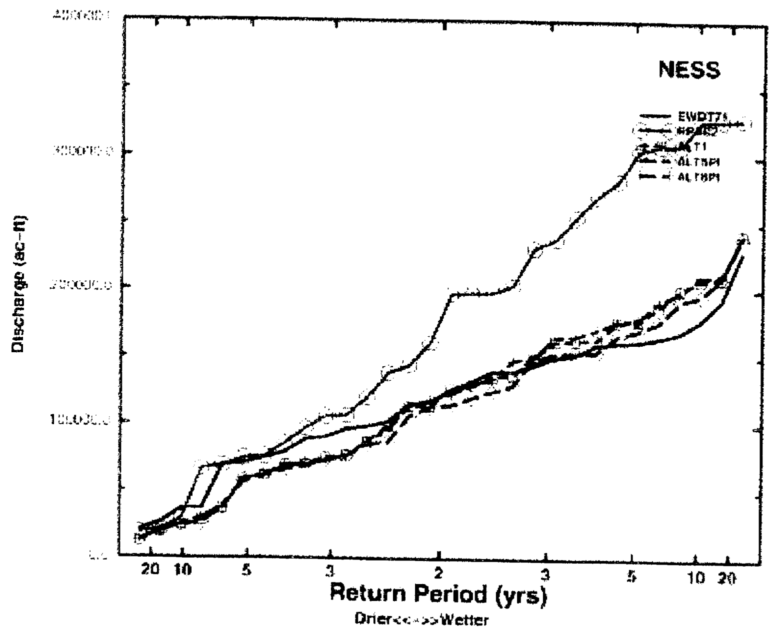


Figure 6.23. Frequency of wet season flows, in acre-feet to the Northeast Shark Slough.

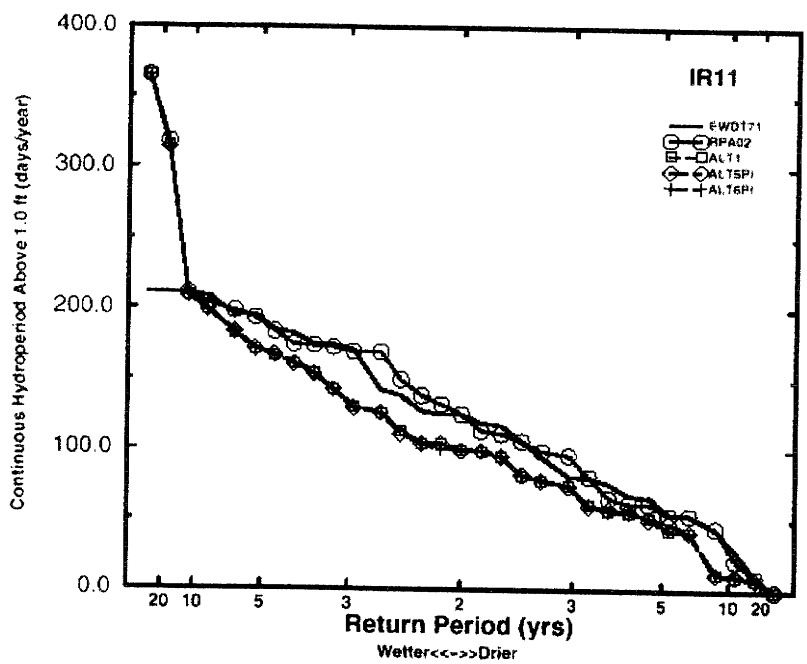


Figure 6.24. Continuous hydroperiod of water depth equal or greater than 1.0 feet for Indicator Region 11.

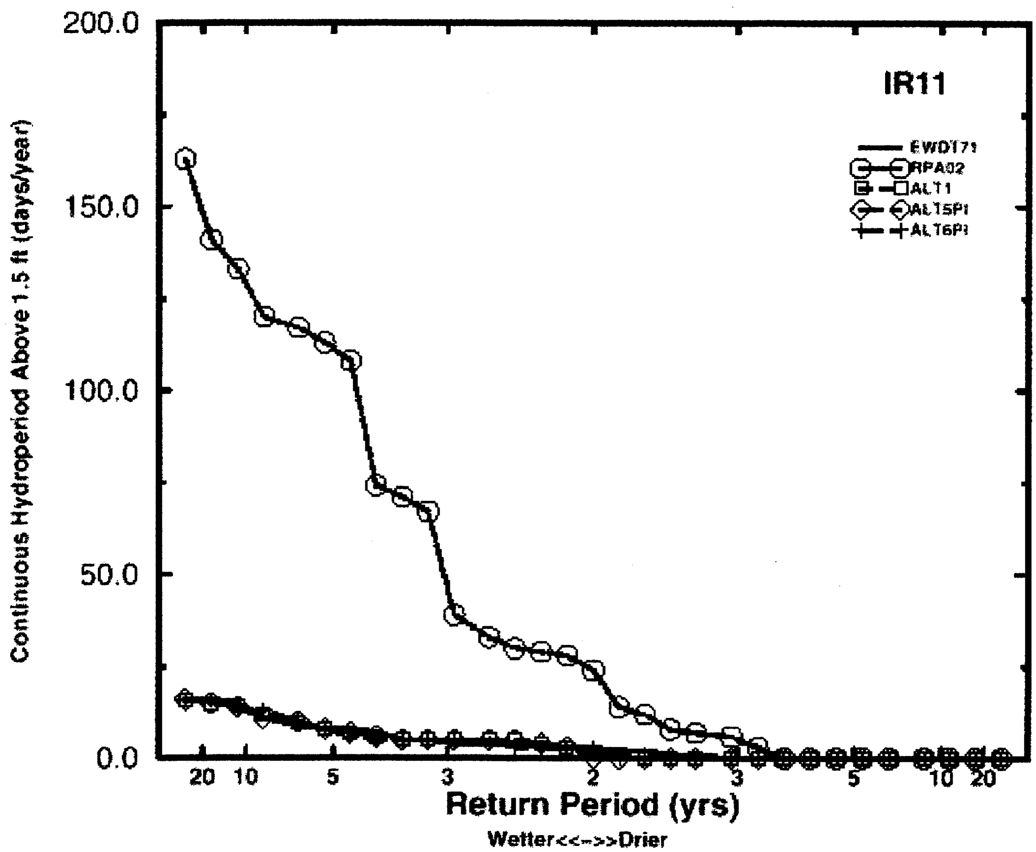


Figure 6.25. Continuous hydroperiod of water depth equal or greater than 1.5 feet for Indicator Region 11.

slough vegetation development and for peat formation **(Figures 6.26)**. Under such a regime, even with the long hydroperiods of wet years, it is unclear that NESS could/could not function as a peat accreting system because of the long dryouts and fire potential during average conditions and in the inevitable Everglades droughts. In this sense, none of the alternatives provide any benefits relative to the EWDT71 base condition, leaving the bulk of the marsh as a sawgrass stand indicative of overdrained conditions.

6.7.1.2 Water Quality

Table 6.1 lists the estimated marsh ready phosphorus loads through S-333, S-355A, and S-355B and S-334 for each alternative. The total marsh ready phosphorus loads entering NESS is the sum of the loads through S-333 and the S-355 Structures minus the loads through S-334.

6.7.2 Southern Shark Slough

Table 6.1. Estimated marsh ready phosphorus loads entering Northeast Shark Slough through S-333 minus phosphorus loads discharged at S-334.

Loads to NESS

Alternative	P Load at S-333	P Load at S-355s	P Load at S-334	Total P load to NESS
95 Base	5393 kg	1253 kg	0 kg	6646 kg
RPA02	5393 kg	1166 kg	0 kg	6559 kg
Alt1P1	6448 kg	1382 kg	2098 kg	5732 kg
Alt5P1	6330 kg	1339 kg	2098 kg	5571 kg
Alt6P1	6448 kg	1382 kg	2098 kg	5732 kg

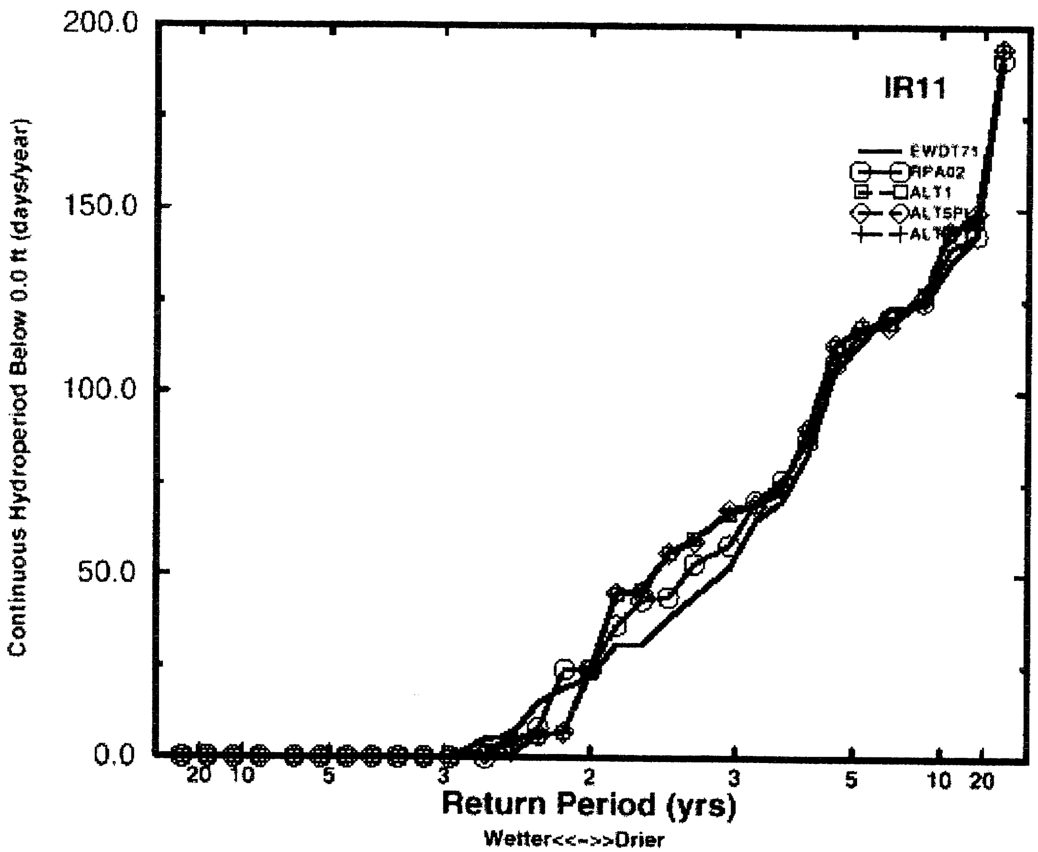


Figure 6.26. Continuous hydroperiod of water depth below ground surface in Indicator Region 11.

Southern Shark Slough, which for this analysis is taken as IR 9 and 10 **(see Figure 6.27)**, is likely to see only relatively small changes, according to these simulations. The maximum annual peak depth, shown in **Figure 6.27**, is very similar among all alternatives. In terms of hydroperiods, **(Figure 6.27)**, all alternatives have very similar performance. However, the Alt1, Alt5P1 and Alt6P1 are expected to have shorter hydroperiods under average to slightly above average conditions relative to EWDT71. For deeper depths, inundation lengths show less difference, but a similar pattern exhibited in IR 11. **Figure 6.28** shows that all alternatives display the anomalous long durations of inundation about 1.0 feet during very wet years seen in EWDT71. The pattern exhibited in IR 11 and 10 of a 12 month hydroperiod exceeding 1.0 feet is not repeated further south, in IR 9 **(Figure 6.29)**. For this metric all simulations show similar hydroperiods relative to EWDT71 for "1-in-3" to "1-in-10" wet years. However, from the former through "1-in-5" dry years hydroperiods simulated for the Alt1, Alt5P1 and Alt6P1 are lower than those of EWDT71.

6.7.2.1 Tree Islands and other Vegetation; Slough Animal Communities

As previously noted, the alternatives differ relatively little among themselves and in comparison to the base (EWDT71) in Shark Slough **(Figure 6.27).** However, under none of the alternatives is there sufficient depths and flooding durations to promote healthy slough communities. Therefore, the small differences among alternatives that do exist are ecologically trivial. All the alternatives with the exception of the RPA, in fact, would worsen the already overdrained pattern as evidenced in EWDT71. In this sense, RPA is relatively superior in mid- and southern Shark Slough as it is either equivalent to the current condition or slightly better. For average rainfall conditions, there is little difference in the length of continuous hydroperiods under the range of alternatives compared to the base conditions in mid-Shark Slough (IR 10). The duration of conditions damaging to aquatic slough communities including aquatic animals (especially the larger fishes), alligators and slough vegetation is seen in the depression of water levels below the soil surface in even slightly ("1-in-3") dry years and increasingly so with falling rainfall **(Figure 6.30)**. Clearly in a "1-in-5" dry period, approximately 3 months with water depths below the ground surface will eliminate most of the aquatic animals that could not reach the sparse deep refugia. Overall, as well, aquatic primary and secondary productivity would continue to be suppressed. Peat accretion in the sloughs will continue to be impaired and even further reduced in the alternatives. Fire risk (and attendant tree island damage potential) would remain high in the alternatives in average and dry years.

6.7.2.2 Water Quality

Table 6.2 lists the estimated marsh ready phosphorus loads entering ENP through the C-111 structures (S-332B and S-332D) and the Coastal Basin (S-18C) by each alternative.

6.8 Estuaries

The effects on the estuaries are likely related to changes in the volume, timing, and distribution of flows. For the western estuaries of Shark Slough, all plans (the alternatives and RPA simula-

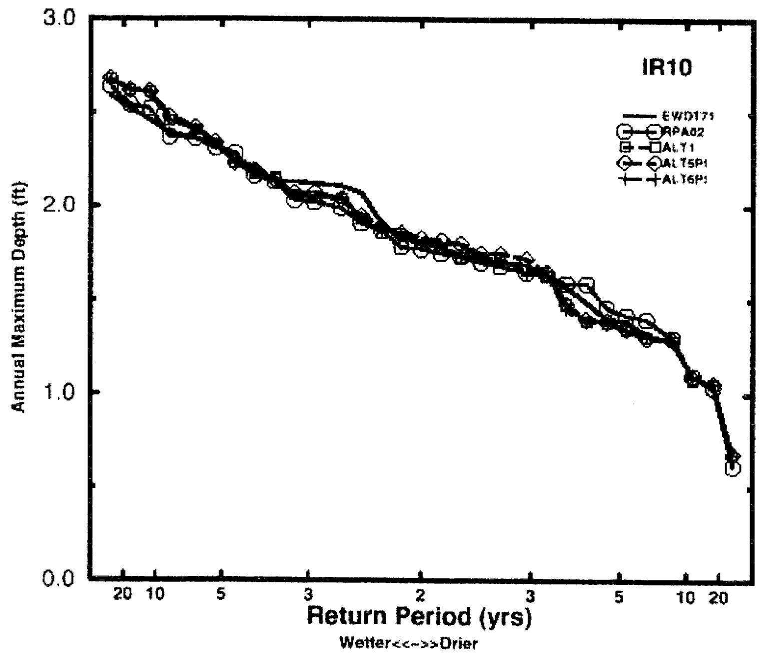


Figure 6.27. Annual maximum water depths for Indicator Region 10.

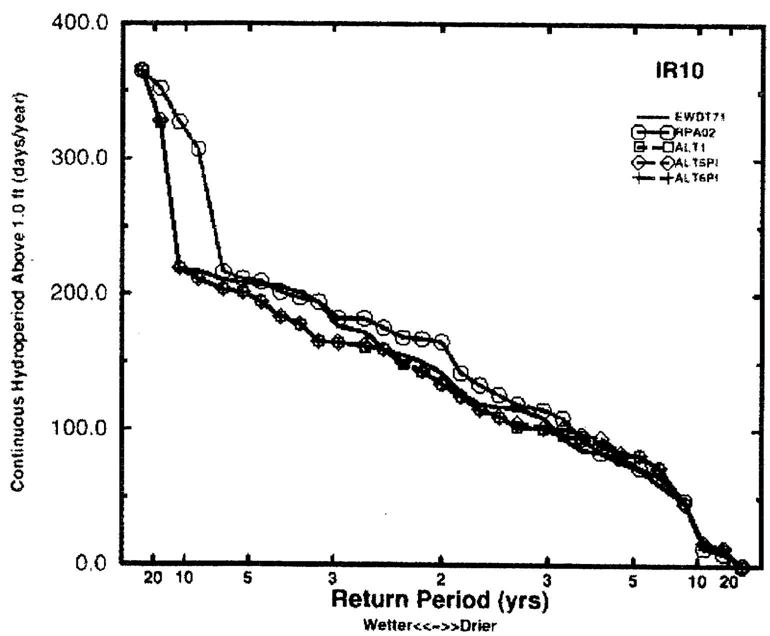


Figure 6.28. Continuous hydroperiod of water depth equal or greater than 1.0 feet for Indicator Region 10.

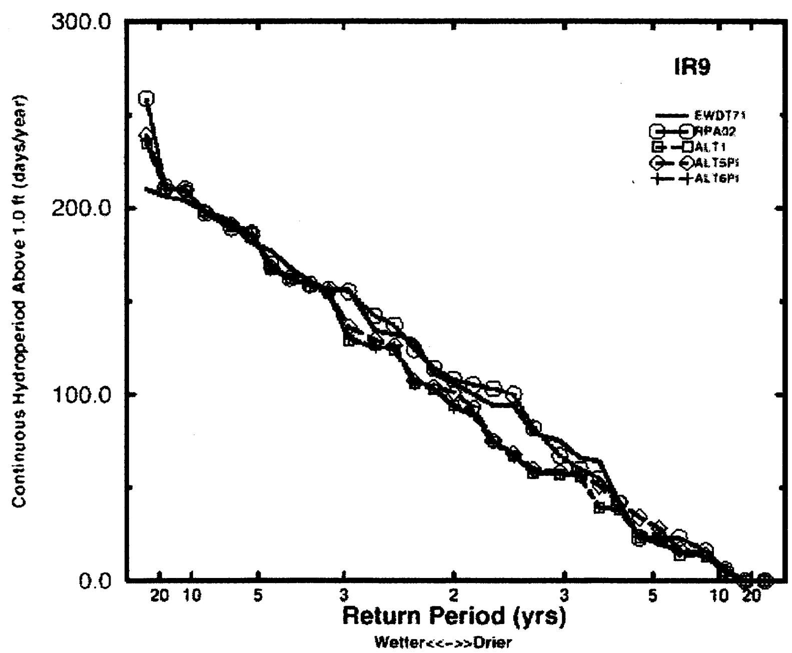


Figure 6.29. Continuous hydroperiod of water depth equal or greater than 1.0 feet for Indicator Region 9.

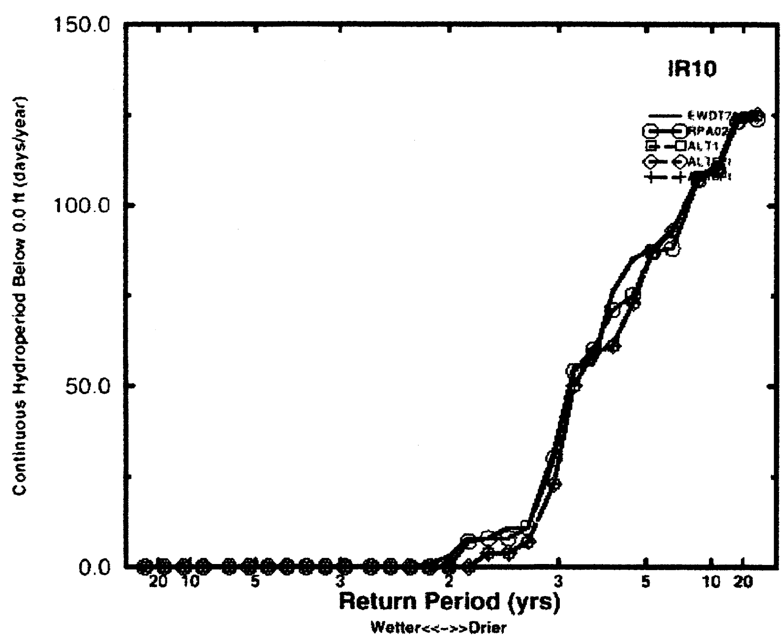


Figure 6.30. Continuous hydroperiod of water depth equal or less than 0.0 feet for Indicator Region 9.

Table 6.2. Loads to ENP from C-111 and Coastal Basin.

Alternative	P Load (kg) @ S-332B	P Load (kg) @ S-332D	P Load (kg) @ S-18C	Total P Load (kg)
95 Base	0	3155	1166	7321
RPA02	0	2997	1388	4385
Alt1	1018	3477	1888	6383
Alt5P1	1758	3454	1666	6878
Alt6P1	1111	3429	1721	6291

tions) have very similar volumes on a frequency of occurrence basis **(see Figures 6.31)**, and all are below EWDT71 flow estimates. This difference between EWDT71 conditions and the alternatives is largest during wetter years, but is also evident during drier than normal years. Roughly speaking, the RPA splits the difference of the other plans which are all less than a maximum of approximately 100,000 acre-feet annually.

The expected surface flows across Tamiami Trail, do show this same pattern. **Figure 6.32** shows that total surface flows across Tamiami Trail from L-30 to Forty-Mile Bend appreciably change under the Alt1, Alt5P1 and Alt6P1 relative to either EWDT71 and RPA for most years. The ISOP/IOP alternatives uniformally predict considerably less total flow at this cross-section. This suggest that the RPA simulation represents a redistribution of surface water flows into Shark Slough, while the alternatives represent a reduction and redistribution of surface flows into Shark Slough. This reduction and redistribution is the consequence of routing WCA-3A regulatory flows to eastern CSSS sub-population C-F and increased flows to tide.

The distribution of surface water flows is quantified in **Figures 6.33 and 6.34**. In western Shark Slough (from L-67A to Forty-Mile Bend), all alternatives represent a significant reduction in flow volumes. The RPA generally has the least reduction relative to EWDT71 while the ISOP/IOP alternatives has the greatest. In NESS, ISOP/IOP alternatives actually generate about 20-30 % less surface water flow during the wetter periods than the RPA. A similar reduction in flows for these alternatives relative EWDT71 is observed from "1-in-3" dry years to "1-in-3" wet years, despite the increased flows indicated by **Figures 6.23 and 6.24**. The RPA generates significantly more surface water flows, approximately 300,000 acre-feet more than EWDT71.

The timing of the flows towards the estuaries of lower Shark Slough is also expected to undergo some changes. **Figures 6.35** shows the average monthly volume normalized by the average annual volume, which is a measure of timing of flow. All alternatives and RPA simulations show the same basic pattern. Relative to EWDT71, there will be a shift of flow from late dry season to the late wet season/early dry season. That is, a greater fraction of the inflows will occur in September, October and November, and lesser amounts in March, April and May.

In terms of flows towards the estuaries downstream of Taylor Slough, all alternatives show very

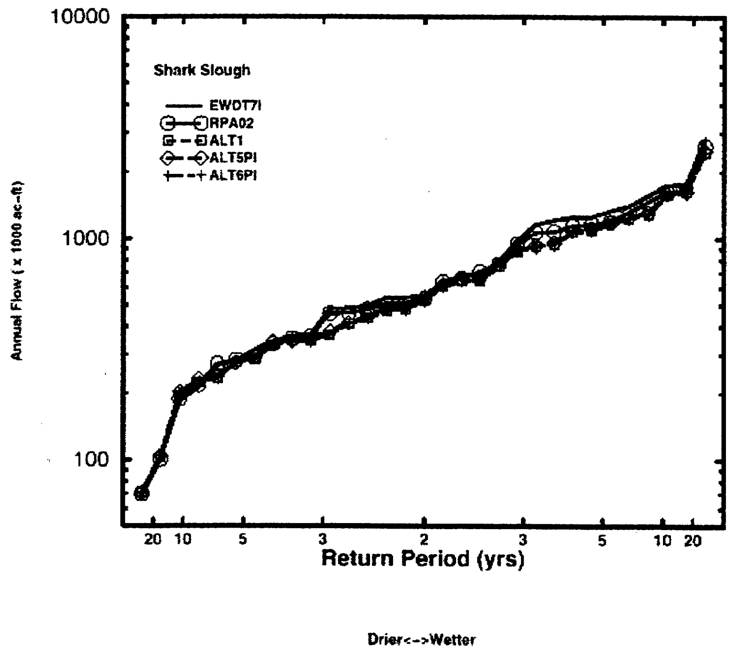


Figure 6.31. Shark Slough annual flows towards the estuary, in thousands acre-feet.

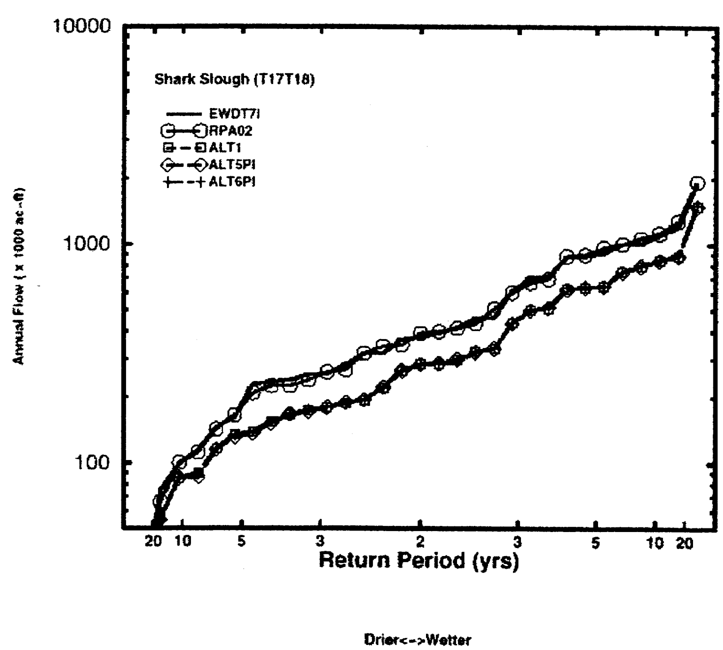


Figure 6.32. Shark Slough annual flows at Tamiami Trail (L-30 to Forty Mile Bend), in thousands acre-feet.

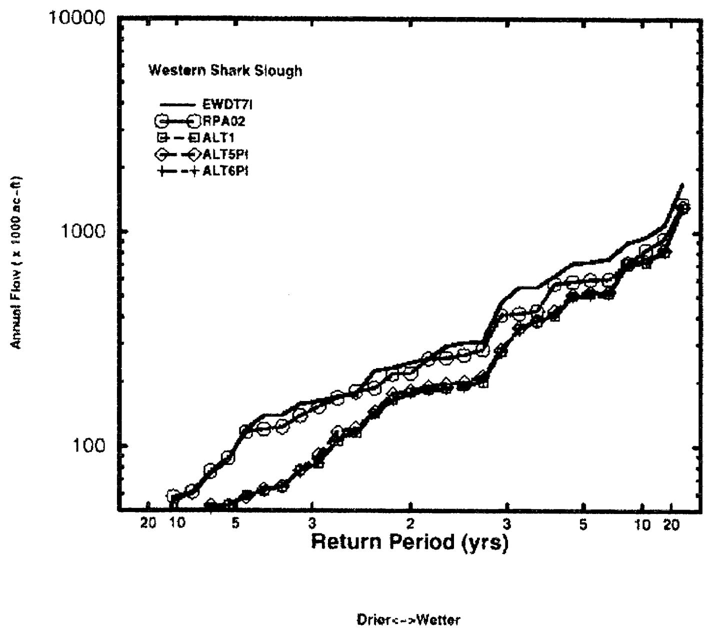


Figure 6.33. Western Shark Slough annual flows (L-67 Ext to Forty Mile Bend), in thousands acre-feet.

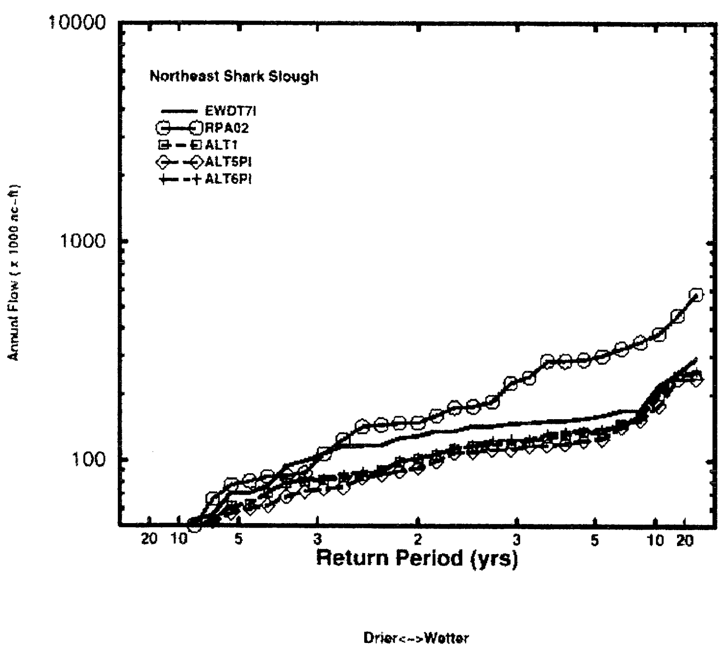


Figure 6.34. Northeast Shark Slough annual flows (L-30 to L-67 Ext), in thousands acre-feet.

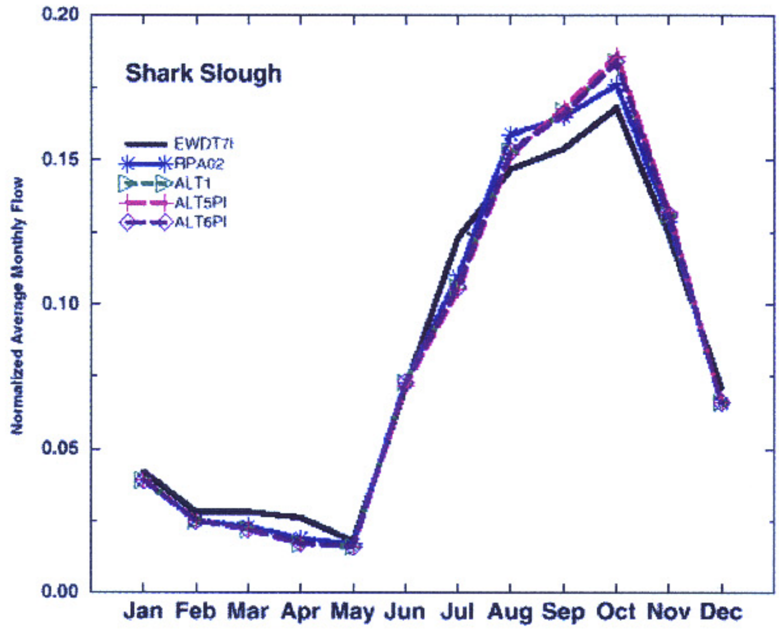


Figure 6.35. Shark Slough annual flows, in thousands acre-feet.

similar estimates of surface flow towards Florida Bay as shown in **Figures 6.36 and 6.37**. In general all alternatives show decreased annual flows towards Florida Bay relative to EWDT71. Throughout the rainfall conditions simulated the RPA falls below the ISOP/IOP alternatives. This suggest that the operational strategy of employed in the ISOP/IOP, which introduces water from WCA-3A into the SDCS, does significantly increase the likelihood of releases into C-111. Interestingly, the differences between these alternatives and the RPA, which increases SDCS operational stages produce similar annual flows. The difference in timing is shown in **Figure 6.37**. The major differences in all alternatives relative to the EWDT71 occur in the wet season; early wet season flows are decreased, while late wet season flows are increased relative to EWDT71. Dry season flows are largely unchanged.

For Florida Bay/Shark Slough estuary ecological restoration, it is very difficult to provide an accurate assessment for each alternative given the uncertainties using the P-33 Stage salinity relationship in each of the 5 coastal basins of Florida Bay/Shark Slough **(see Figure 6.38)**. Of the five coastal basins, the North River basin, is selected to best represent the effects of the flows (thus salinities) from the Shark Slough system (see Van Lent et al. 1999). The goal here is to reduce the frequency of the undesirable high salinity events of 20-40 ppt and >40 ppt and increase the frequency of low salinity (>20 ppt) events in the coastal basin. These salinity regimes were compared based on the life history (nursery and spawning habits and habitats) and salinity requirements of the dominant estuarine-dependent sportfish (spotted seatrout and snook) found in the coastal basin. Snook are known to spend their juvenile and adult life history stages in the estuary while spotted seatrout spend their entire life history in the estuary. Their spawning and nursery characteristics such as survival = abundance are increased during lower salinity periods

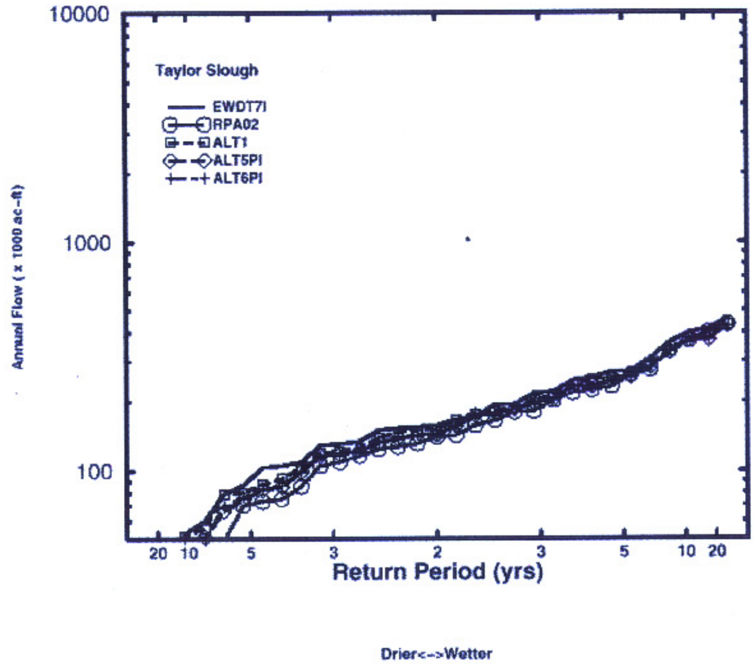


Figure 6.36. Taylor Slough annual flows, in thousands acre-feet.

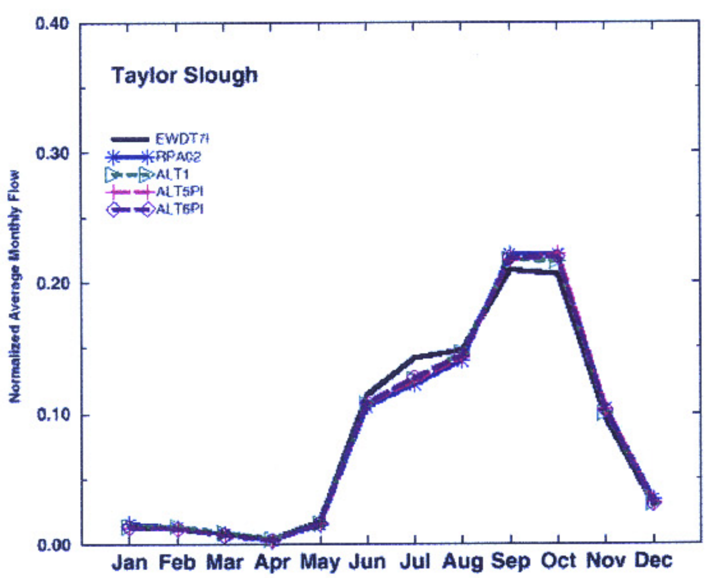


Figure 6.37. Taylor Slough normalized average monthly flows.

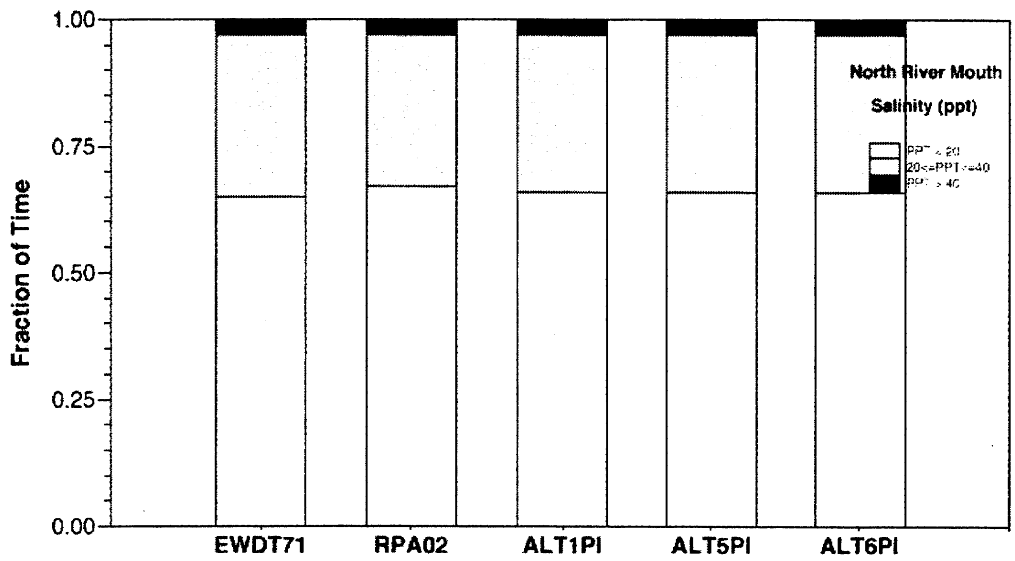


Figure 6.38. Salinity estimates Florida Bay based upon P-33 stages.

and are decreased during high salinity (> 40 ppt) events.

Based on the fraction of time that high (>40 ppt) salinity conditions are projected for the North River system **(see Figure 6.38)**, no differences between the EWDT71, the RPA, and the proposed alternatives are observed. For all alternatives, approximately 9 months over the 31 year simulation period would be expected to be hypersaline (> 40 ppt). The significance of the monthly salinity differences as represented in **Figure 6.38** and average annual wet and dry season flows **(Figure 6.35)** shows that all alternatives except EWDT71 exhibit lower flows during the dry season (March, April, May) when hypersaline conditions normally prevail in the coastal basin. Subsequently, EWDT71 would more than likely provide the greatest flow and the least number of high salinity conditions in the coastal basin, thus resulting in an increase in the abundance, survival and recruitment of the dominant sportfish in the North River system.

6.9 Compilation of Other Natural Resources Evaluations

A number of performance measures were evaluated in this chapter for assessment of the hydrologic effects of the proposed ISOP plans on the other natural resources throughout the southern Everglades. The method described in Chapter 5 is applied to compile the measures examined throughout this chapter to form a number of matrices to further assist in the decision making process. The results for NESS and the Rocky Glades, Southern Shark Slough and the estuaries are shown in **Table 6.3**. Graphical depiction of the information in these tables is presented in **Figures 6.39 through 6.43**. These figures indicate that the best overall performance of an alternative by area is EWDT71 followed very closely by the RPA. In each area EWDT71 shows the

Table 6.3. Interim Operating Plan Performance Scores for Priority Three Objectives.

OTHER NATURAL RESOURCES: WATER CONSERVATION AREA 3A					
	Alternative Scores				
	Base Condition	**Corps Preferred Alternative**	**Other Alternatives**		
	Test 7 Phase 1	**Alternative 5**	**Alternative 1**	**Alternative 6**	**RPA**
PERFORMANCE MEASURES		**Phase 1-IOP 2B***	**ISOP 9dR**	**IOP 5a**	**RPA 02**
PRIORITY 3 PROJECT OBJECTIVES (CONTINUED)					
3-Evaluate Effects on Water Conservation Area 3A (WCA3A)					
3A-Tree Islands (WCA-3A)					
3A1-Stage duration above 2.5 feet	5	4	4	4	1
Objective Subtotal Mean Score	5	4	4	4	1
3B-Slough Vegetation (WCA-3A)					
3B1-Continuous hydroperiods	5	1	1	1	5
3B2-Minimize low water	1	1	1	1	1
Objective Subtotal Mean Score	3	1	1	1	3
3C-Water Quality (WCA-3A)					
3C1-Duration below ground surface	4	1	1	1	5
Objective Subtotal Mean Score	4	1	1	1	5
3D-Wading Bird Foraging Habitat (WCA-3A)					
3D1-Foraging depths	1	1	1	1	1
Objective Subtotal Mean Score	1	1	1	1	1
3E-Aquatic Communities (WCA-3A)					
3E1-Low water events	1	1	1	1	1
3E2-Low water average duration	1	1	1	1	1
3E3-Inundation duration	1	1	1	1	1
Objective Subtotal Mean Score	1	1	1	1	1
Aggregate Mean Scores for all WCA-3A Project Objectives	**14**	**8**	**8**	**8**	**11**

Table 6.3. cont. Interim Operating Plan Performance Scores for Priority Three Objectives.

OTHER NATURAL RESOURCES: WATER CONSERVATION AREA 3B					
	Alternative Scores				
	Base Condition	Corps Preferred Alternative	Other Alternatives		
	Test 7 Phase 1	Alternative 5	Alternative 1	Alternative 6	RPA
PERFORMANCE MEASURES	Test 7 Phase 1	Phase 1-IOP 2B*	ISOP 9dR	IOP 5a	RPA 02
PRIORITY 3 PROJECT OBJECTIVES (CONTINUED)					
3-Evaluate Effects on Water Conservation Area 3B (WCA-3B)					
3F-Tree Islands (WCA-3B)					
3F1-Stage duration above 2.5 feet	1	1	1	1	1
Objective Subtotal Mean Score	1	1	1	1	1
3G-Slough Vegetation (WCA-3B)					
3G1-Continuous hydroperiods	5	1	1	1	5
Objective Subtotal Mean Score	5	1	1	1	5
3H-Water Quality (WCA-3B)					
3H1-Duration below ground surface	5	1	1	1	5
Objective Subtotal Mean Score	5	1	1	1	5
3I-Wading Bird Foraging Habitat (WCA-3B)					
3I1-Foraging depths	1	1	1	1	1
Objective Subtotal Mean Score	1	1	1	1	1
3J-Aquatic Communities (WCA-3B)					
3J1-Low water events	5	1	1	1	5
3J2-Low water average duration	1	1	1	1	1
3J3-Inundation duration	5	1	1	1	4
Objective Subtotal Mean Score	4	1	1	1	3
Aggregate Mean Scores for all WCA-3B Project Objectives	**16**	**5**	**5**	**5**	**15**

Table 6.3. cont. Interim Operating Plan Performance Scores for Priority Three Objectives.

OTHER NATURAL RESOURCES: NORTHEAST SHARK SLOUGH AND ROCKY GLADES					
	Alternative Scores				
	Base Condition	Corps Preferred Alternative	Other Alternatives		
	Test 7 Phase 1	Alternative 5	Alternative 1	Alternative 6	RPA
PERFORMANCE MEASURES	Test 7 Phase 1	Phase 1-IOP 2B*	ISOP 9dR	IOP 5a	RPA 02
PRIORITY 3 PROJECT OBJECTIVES (CONTINUED)					
3-Evaluate Effects on Northeast Shark Slough (NESS)					
3K-Tree Islands (NESS)					
3K1-Stage duration above 2.5 feet	1	1	1	1	1
Objective Subtotal Mean Score	1	1	1	1	1
3L-Slough Vegetation (NESS)					
3L1-Continuous hydroperiods	4	1	1	1	5
3L2-Minimize low water	1	1	1	1	1
Objective Subtotal Mean Score	3	1	1	1	3
3M-Water Quality (NESS)					
3M1-Capacity for water quality treatment of P loads	5	1	3	3	4
Objective Subtotal Mean Score	5	1	3	3	4
3N-Wading Bird Foraging Habitat (NESS)					
3N1-Foraging depths	1	1	1	1	1
Objective Subtotal Mean Score	1	1	1	1	1
3O-Aquatic Communities (NESS)					
3O1-Low water events	1	1	1	1	1
3O2-Low water average duration	4	1	1	1	5
3O3-Inundation duration	4	1	1	1	5
Objective Subtotal Mean Score	3	1	1	1	4
3P-Water Quality (Rocky Glades)					
3P1-Capacity for water quality treatment of P loads	5	2	1	3	4
Objective Subtotal Mean Score	5	3	2	1	4
Aggregate Mean Scores for all NESS Project Objectives	**18**	**8**	**9**	**8**	**17**

Table 6.3. cont. Interim Operating Plan Performance Scores for Priority Three Objectives.

OTHER NATURAL RESOURCES: SOUTHERN SHARK SLOUGH					
	Alternative Scores				
	Base Condition	**Corps Preferred Alternative**	**Other Alternatives**		
	Test 7 Phase 1	**Alternative 5**	**Alternative 1**	**Alternative 6**	**RPA**
PERFORMANCE MEASURES	**Test 7 Phase 1**	**Phase 1-IOP 2B***	**ISOP 9dR**	**IOP 5a**	**RPA 02**
PRIORITY 3 PROJECT OBJECTIVES (CONTINUED)					
3-Evaluate Effects on Southern Shark Slough (SSS)					
3Q-Tree Islands (SSS)					
3Q1-Stage duration above 2.5 feet	1	1	1	1	1
Objective Subtotal Mean Score	1	1	1	1	1
3R-Slough Vegetation (SSS)					
3R1-Continuous hydroperiods	4	1	1	1	5
Objective Subtotal Mean Score	4	1	1	1	5
3S-Water Quality (SSS)					
3S1-Capacity for water quality treatment of P loads	5	1	3	3	4
Objective Subtotal Mean Score	5	1	3	3	4
3T-Wading Bird Foraging Habitat (SSS)					
3T1-Foraging depths	1	1	1	1	1
Objective Subtotal Mean Score	1	1	1	1	1
3U-Aquatic Communities (SSS)					
3U1-Low water events	5	1	1	1	1
3U2-Low water average duration	5	1	1	1	1
3U3-Inundation duration	4	1	1	1	5
Objective Subtotal Mean Score	5	1	1	1	2
Aggregate Mean Scores for all SSS Project Objectives	**16**	**5**	**7**	**7**	**13**

Table 6.3 cont. Interim Operating Plan Performance Scores for Priority Three Objectives.

OTHER NATURAL RESOURCES: ESTUARIES					
	Alternative Scores				
	Base Condition	Corps Preferred Alternative	Other Alternatives		
	Test 7 Phase 1	Alternative 5	Alternative 1	Alternative 6	RPA
PERFORMANCE MEASURES	Test 7 Phase 1	Phase 1-IOP 2B*	ISOP 9dR	IOP 5a	RPA02
PRIORITY 3 PROJECT OBJECTIVES (CONTINUED)					
3-Evaluate Effects on Estuaries					
3V-Shark Slough Estuaries					
3V1-Salinity regimes-Salinity at North River Mouth	1	1	1	1	1
3V2-Total annual discharge	5	1	1	1	4
Objective Subtotal Mean Score	3	1	1	1	3
3W-Florida Bay					
3W1-Average annual wet and dry season surface flow	1	5	5	5	5
3W2-Normalized Average monthly flow to Florida Bay	1	5	5	5	5
3W3-Average monthly flow to Florida Bay	1	5	5	5	5
Objective Subtotal Mean Score	1	5	5	5	5
Aggregate Mean Scores for all Estuary Project Objectives	**4**	**6**	**6**	**6**	**8**

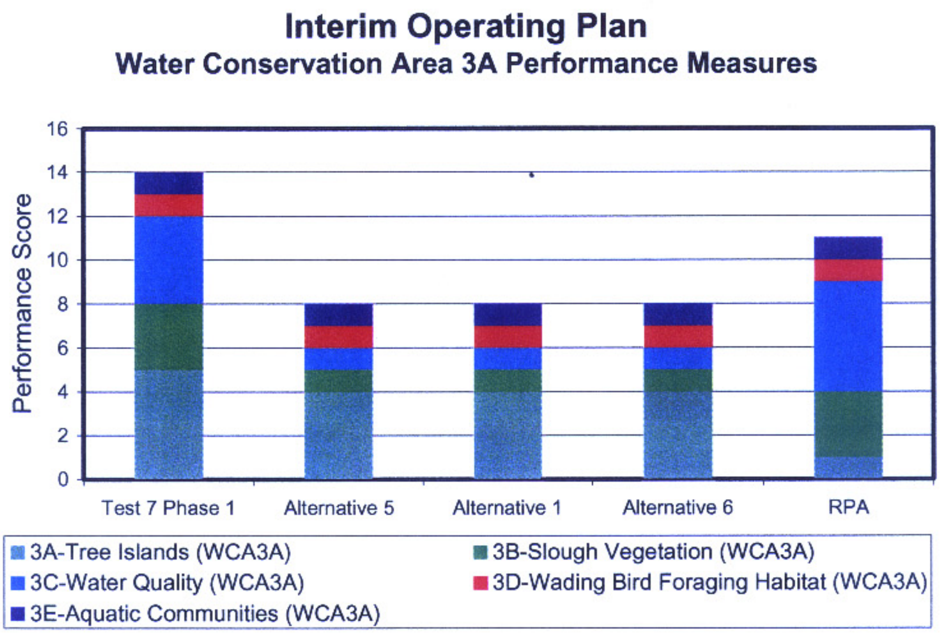


Figure 6.39. Aggregate measure of performance scores for Priority Three Objectives, WCA-3A.

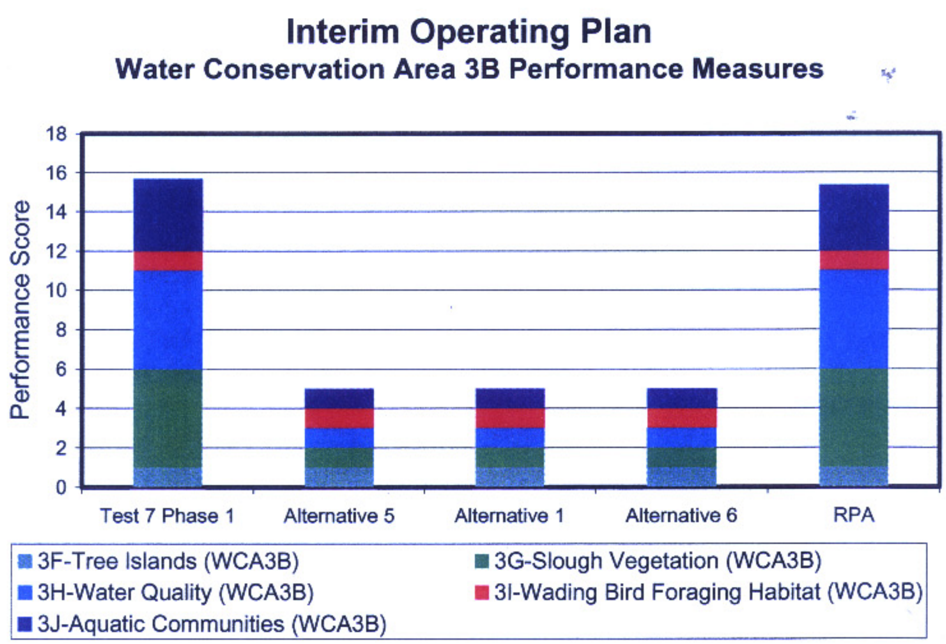


Figure 6.40. Aggregate measure of performance scores for Priority Three Objectives, WCA-3B.

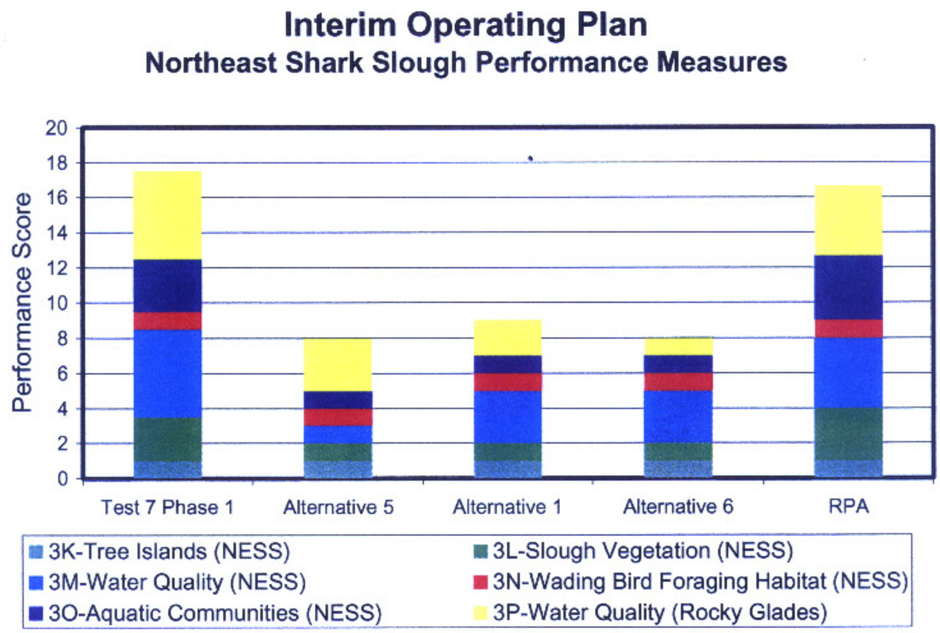


Figure 6.41. Aggregate measure of performance scores for Priority Three Objectives, Northeast Shark Slough.

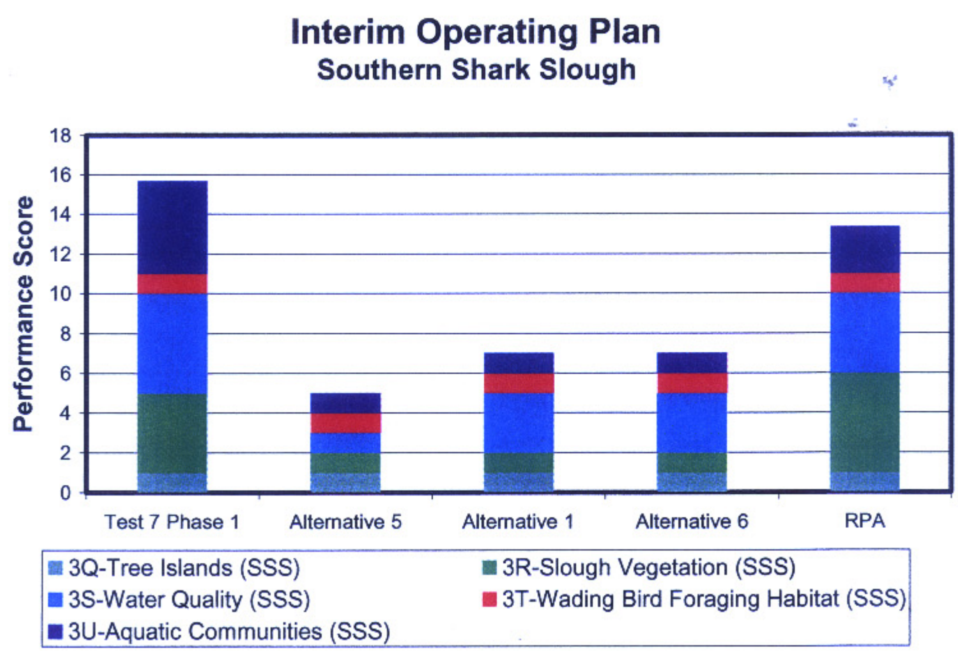


Figure 6.42. Aggregate measure of performance scores for Priority Three Objectives, Southern Shark Slough.

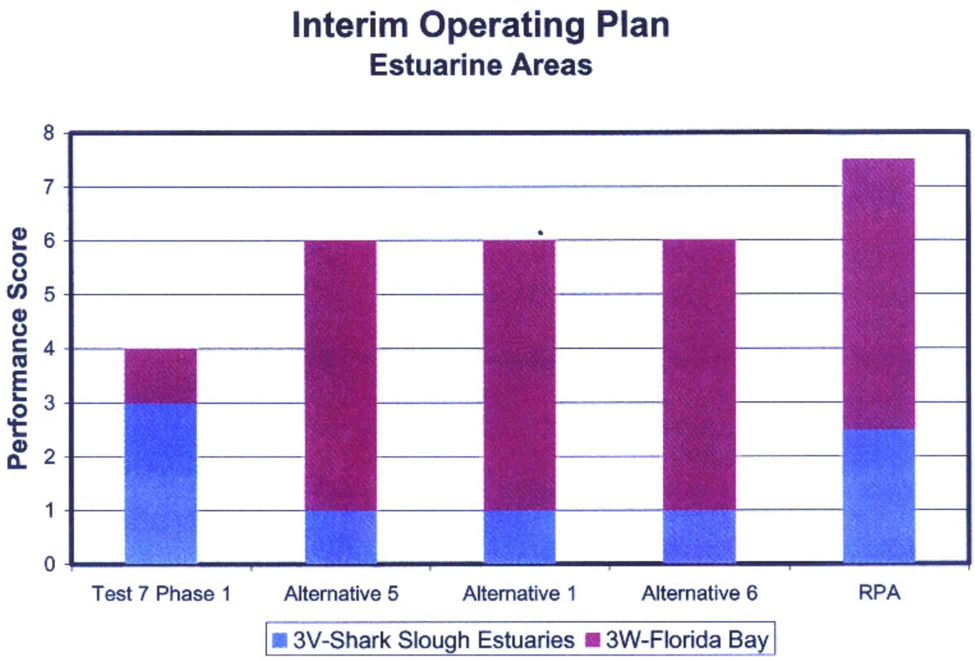


Figure 6.43. Aggregate measure of performance scores for Priority Three Objectives, Estuaries.

best performance with the exception of the estuaries, where the RPA show significant improvement.

Literature Cited

Van Lent, T., R.W. Snow and F.E. James. 1999. An examination of the modified water deliveries project, the C-111 Project, and the experimental water deliveries project: hydrologic analyses and effects on endangered species. South Florida Natural Resources Center, Everglades Nat. Park, Florida.

Summary, Conclusions and Recommendations

Cape Sable Seaside Sparrow

We have analyzed the available information with respect to the Cape Sable seaside sparrow, other Threatened and Endangered Species, and other ecological resources in the study area and reached the following conclusions:

Sub-population A

- For sub-population A, all of the scenarios are an improvement over EWDT71, however none of the scenarios examined provide an average hydroperiod expected to support recovery of large areas of favorable sparrow habitat in the long term. However, our analysis indicated that Alternatives 1, 5 and 6 provide the maximum improvement possible with the existing water management system. The best scientific information currently available indicates that Alt1, Alt5P1, Alt6P1 and RPA02 for sub-population A meet the requirement in section 7(a)(2) of the ESA that the Corps ensure that any action authorized, funded, or carried out by the Corps is not likely to jeopardize the continued existence of the sparrow or result in the destruction or adverse modification of the sparrow`s designated critical habitat.

- For sub-population A all scenarios examined provide a significantly greater nesting window than EWDT71.

Sub-population B

- In sub-population B, all of the scenarios examined provide an average hydroperiod expected to support vegetation favorable to sparrow nesting and all provide a nesting window considered favorable for persistence.

Sub-population C

- In sub-population C, all of the scenarios examined provide an average hydroperiod expected to support vegetation favorable to sparrow nesting and all provide a nesting window considered favorable for persistence.

Sub-population D

- In sub-population D, none of the scenarios, including RPA02, provide an average hydroperiod expected to support favorable sparrow habitat in the long term. Analysis of actual implementation of IOP Alt1 operations indicates that Alt1, Alt5P1 and Alt6P1 will likely further increase hydroperiods in sub-population D, reducing suitable sparrow habitat as compared to conditions prior to the February 19, 1999, biological opinion. All scenarios examined provide a nesting window considered favorable for persistence.

Sub-population E

- In sub-population E, only RPA02 is likely to provide improvement in sub-population E habitat water depths and hydroperiods. RPA02 is also likely to reduce the chances of catastrophic fire in this sub-population, as compared to conditions prior to the February 19, 1999, biological opinion.

- In sub-population E, Alt1, Alt5P1 and Alt6P1 are not likely to provide improvement in water depths and hydroperiods within the sparrow habitat. Additionally, the very low canal stages included in these alternatives are likely to cause additional over-drainage of marsh areas along the eastern border of ENP. Overdrainage could increase the likelihood that large fires will start in these areas and increase the likelihood that fires will move into the sub-population E habitat. A fire of this kind occurred during the ISOP 2001 (same as Alt1) operations this year, burning about one third of the subpopulation E habitat.

Sub-population F

- For sub-population F, RPA02 will provide improvements in sub-population F habitat conditions necessary to reduce the chances of extirpation of this sub-population.

- Only RPA02 meets the requirement in Section 7(a)(2) of the ESA that the Corps ensure that any action authorized, funded, or carried out by the Corps is not likely to jeopardize the continued existence of the sparrow or result in the destruction or adverse modification of the sparrow's designated critical habitat.

- In the sub-population F habitat, S-332B operations modeled in the IOP alternatives are likely to substantially increase water levels and hydroperiods in most of the southern part of sub-population F habitat. Hydroperiods and water levels are likely to decrease under these S-332B operations in the northern portion of the sub-population sparrow habitat F as compared to EWDT71 operations that were analyzed in the February 19, 1999, biological opinion. This further reduction in hydroperiod may further increase the risk of large fires in this area. For sub-population F habitat areas near S-332B, these operations are likely to produce very much wetter conditions than called for in the RPA, raising concerns that habitat in this area would be converted to sawgrass-dominated vegetation unsuitable for sparrows. Additionally, actual operations identical to those proposed in Alt1 have resulted in surface water spillover from the S-332B retention area into the sparrow habitat. Water quality monitoring has detected high phosphorus concentrations during a spillover event, and a flush of vegetation indicative of high phosphorus levels has already been observed directly adjacent to the retention area.

- FWS concludes that Alt1, Alt5P1 and Alt6P1 operations are likely to cause mixed effects in sub-population F habitat, with some areas drier than they were under EWDT71, some very much wetter, and others in a range favorable to recovery of sparrow habitat. The exact extent of each of these kinds of effects, and the resulting effects on sparrow numbers in this area, can only be determined through monitoring of actual operations. However, monitoring already conducted, and analysis presented in Chapter 4, constitute the best scientific information currently available on this topic, and support the FWS' conclusion that Alt1, Alt5P1 and Alt6P1 will likely cause additional adverse effects to sparrows and sparrow habitat in sub-population F through flooding of areas closest to the S-332B retention area (s) and additional over-drainage of areas north of the retention area (s). These would be adverse effects above and beyond those anticipated in the FWS's February 19, 1999, incidental take statement, and would, therefore, be subject to the ESA's section 9 prohibitions.

- The second retention area proposed as part of Alt6P1 should reduce the likelihood of spillover and should broaden the area influenced by S-332B pumping. However, very long hydroperiods and some spillover into sparrow habitat are likely even under Alt6P1, particularly when we take into account "pre-storm drawdowns", full capacity pumping during flood events, and additional water sent to this area due to actual S-335 operations, that are not included in the SFWMM modeling.

Other Endangered Species

Snail Kite

- Overall, using both evaluation methods for snail kite habitat suitability and focusing on historically important snail kite habitats, EWDT71 and the RPA appear to slightly outperform the other alternatives considered (Alt1, Alt5P1, and Alt6P1).

Wood Stork

- When both Taylor Slough and Shark Slough flow volumes are included the wood stork performance metric suggests that all IOP alternatives would provide marginal conditions for consistent wood stork nesting success in the historical ENP colonies. However, we have reason to believe Taylor Slough flow volumes are overpredicted by the existing model. Without Taylor Slough volumes all alternatives, including the RPA and EWDT71, are considered to provide unsuitable conditions for wood stork nesting success.

American Crocodile and West Indian Manatee

- With respect to providing favorable manatee and crocodile habitat in Shark Slough estuarine areas, this analysis ranks EWDT71 above the RPA, followed by all other alternatives considered.

- Overall, EWDT71 would likely provide the most consistent flows and therefore more favorable habitat conditions for the relatively few manatees using northeast Florida Bay. Overall for crocodiles, EWDT71 appears to provide the more favorable habitat conditions in Florida Bay, followed by Alt1, then Alt5PI and Alt6PI, and lastly the

RPA. However, it should be noted that the relative differences between alternatives is very slight.

- During the late wet season when crocodile hatchlings are most sensitive to high salinities, the RPA provides higher flows to central and southern Biscayne Bay compared to all of the alternatives including EWDT71. These increased late wet season flows may provide more suitable habitat for crocodiles in Biscayne Bay.

- Manatees, however, may benefit from decreased salinities expected under Alt1, Alt5PI, and Alt6PI in central and southern Biscayne Bay during the winter when manatees often use this area as a cold weather refugia.

Other Ecological and Hydrological Effects

A.R.M. Loxahatchee National Wildlife Refuge

- None of the analyzed alternatives had significant ecological effects in WCA-1.

WCA-2A

- None of the analyzed alternatives had significant ecological effects in WCA-2A.

WCA-3A

- None of the analyzed alternatives had significant ecological effects in northern and central WCA-3A.

- All of the analyzed alternatives maintain the current persistent deep ponded conditions in southern WCA-3A. RPA02 had a small increase in undesirable ponding; an increase of the predicted magnitude is unlikely to affect ecological communities. Alt1, Alt5P1, and Alt6P1 are, for all practical purposes indistinguishable from one another in WCA-3A.

WCA-3B

- For WCA-3B, the RPA and EWDT71 are similar in their effects and are superior to the examined alternatives. WCA-3B is likely to experience adverse drainage from operations at S-335 unmodeled in the EIS but implemented in the ISOP and expected to continue in IOP operations.

Northeast Shark Slough

- The RPA outperforms all alternatives and EWDT71 in Northeast Shark Slough. Alt1, Alt5P1, and Alt6P1 perform worse that EWDT71 for Northeast Shark Slough. Under those alternatives Northeast Shark Slough is expected to experience decreased hydroperiods and depths. Alt1, Alt5P1 and Alt6P1 short-circuit the natural Everglades flow system by preferentially routing water from S-335 instead of introducing flow into Northeast Shark Slough.

Rocky Glades

- In the Rocky Glades, we expect, based upon observed data, MODBRANCH modeling, and GFLOW modeling that Alt1, Alt5P1, Alt6P1 will have variable impacts. In the vicinity of S-332D and S-332B, we expect hydroperiod improvements and mitigation of lower canal levels. However, we do not expect the benefits of S-332D and S-332B to extend along the entire length of L-31N, and therefore, these operations do not compensate for lower L-31N canal stages everywhere in the Rocky Glades.

Southern Shark Slough

- In southern Shark Slough, differences between EWDT71, the RPA, and the alternatives, are relatively small. The RPA appears to slightly outperform the other options, but none provide sufficient flow to significantly improve the area.

Florida Bay and Estuaries

- In the western estuaries, the RPA provides improved timing of flow, providing more freshwater inflow during the dry season relative to the other options. All the alternatives perform slightly better than EWDT71 in terms of timing, but worse than EWDT71 for volume of freshwater inflow.

- According to the Corps' modeling, all the alternatives and the RPA perform slightly better in terms of timing of flows to Florida Bay from Taylor Slough and eastern Panhandle. However, we expect that S-335 operations that were not modeled could affect this conclusion.

Other Conclusions

- Urban and agricultural floodwaters routed from the SDCS into Everglades National Park via S-332B and S-332D pose a water quality concern by potentially disrupting the native flora and fauna of Everglades National Park.

- Our analysis of the "Pre-storm drawdown" proposal indicates potentially significant impacts. However, the draft EIS contains no analysis of the consequences of this action.

- Comparisons of MODBRANCH models, GFLOW models, and observed hydrologic data suggest that the SFWMM 2x2 modeling in the EIS overestimates the hydroperiod benefits related to S-332B.

- The Corps has not presented an analysis comparing alternative impacts related to flooding and water supply.

- Overall, none of the IOP alternatives are likely to comply with ESA requirements and all are likely to cause unnecessary harm to other natural resources. Therefore, FWS and NPS find all of the IOP alternatives unacceptable. The recommendations below provide our guidelines on developement of another IOP alternative that should be acceptable to FWS and NPS.

Recommendations

Environmentally Preferred Alternative

- The NPS and FWS are recommending the RPA as the environmentally preferred alternative. This option performs best for the Cape Sable seaside sparrow and provides the most balanced and overall ecological benefit. Moreover, it has the fewest adverse ecological consequences and is most consistent with overall Everglades restoration goals.

Recommendations related to other alternatives

- Although FWS and NPS fully support building the second S-332B retention area and believe that this feature will reduce expected adverse effects, canal stage criteria must also be significantly adjusted from those presented in Alt6P1 in order to eliminate additional adverse effects resulting from flooding of some CSSS habitat areas and over-drainage of others.

- The "Pre-storm drawdown" operations for non-tropical events should not be included in the final selected plan.

- S-334 should be the primary mode of routing WCA-3A regulatory flows to the SDCS. S-335 should only be operated to route excess flows from WCA-3A via S-337, or when needed for water supply during the dry season. S-332B and S-332D should only provide downstream capacity for S-335 flows that is equal to the flow from S-337. The capacity of S-333 should be extended beyond 1350 cfs by providing for additional reinforcement downstream of the structure.

- S-332B detention area should not be allowed to overflow except under very limited emergency circumstances

- Improvements in the SFWMM and the MODBRANCH model should be expedited for the Combined Structural and Operational Plan effort to better represent alternatives that include effects due to local sources and small retention areas, such as S-332B. Results of hydrologic analysis presented in Chapter 4 should be considered in developement of additional IOP alternatives.

- Operations for the IOP should be detailed in an Operations and Maintenance Manual. Agreement should be reached between DOI, Corps and SFWMD that this manual reflects the operations as specified in the final EIS. The manual should include provisions for monitoring and emergency operations, as well as mechanisms for dispute resolution and modifications as a result of new information, to assure compliance in a manner satisfactory to all agencies.
- Mitigative measures for regulatory releases into the SDCS, such as lowering canal stages and increased pumping, should be taken only while making regulatory releases.
- S-332B operation should be regulated by water levels in the sub-population F habitat to preclude adverse effects to the CSSS habitat.
- S-355A and S-355B should be operated to avoid adverse impacts to WCA-3B and NESS. S-355A and S-355B should not be open when water levels in the headwater are less than the tail-water water levels.

Appendix A.

South Florida Water Management District

3301 Gun Club Road, West Palm Beach, Florida 33406 . (561)686-6600 . FL WATS 1-800-432-2045 . TDD (561)697-2574

Mailing Address: P. O. Box 24680, West Palm Beach, FL 33416-4680 . www.sfwmd.gov

RES 17-06

March 2, 2001

Sherry Mitchell- Bruker
Everglades National Park
40001 St. Road 9336
Homestead, FL 33034-6733

Dear Ms. Mitchell- Bruker:

SUBJECT: Response to Everglades National Park concerns on appropriate use of South Florida Water Management Model.

You have expressed concerns regarding the appropriate use of the South Florida Water Management Model (SFWMM) in several emails. Similar questions were raised in the Department of Interior January 2, 2001 Planning Aid Letter (PAL) to Colonel James May. Particular concerns have been expressed regarding the ability of the SFWMM to match field observations, appropriate application of the SFWMM, modeling of the S-332B detention area and model documentation. I write this letter to address each of these issues. However, I would like to clarify at the outset, that the modeling, using the SFWMM undertaken in support of Interim Structural and Operational Plan (ISOP), has been the responsibility of the Corps of Engineers (Corps). South Florida Water Management District staff is responsible for the development of the model and undertook specific code modifications, at the request of the Corps, to enable the SFWMM to simulate reservoirs such as S-332B that are smaller than the grid size of the model.

This letter responds to both your, and the PAL concerns. Furthermore, Colonel May has already responded (January 22, 2001) to the January 2, 2001 PAL concerns regarding the Corps selection and use of the SFWMM. Where possible, I quote the specific concern to be sure that I address it. Letters from which the quotes are extracted are included as attachments to provide the context of the quotes. Attachments are arranged chronologically.

Concern 1. Ability of SFWMM to match field observations.

> "The park has expressed concern that the model results from the SFWMM are quite different than the hydrology observed in the field."
>
> *Mitchell, Dec. 19, 2000. (Attachment 4)*

This is a generalized statement, which can be very misleading. As a regional-scale tool, the SFWMM has been calibrated and validated against numerous field observations and the calibration/validation results have been shared widely. SFWMM documentation (SFWMD, 1999) available on the internet at (`http://www.sfwmd.gov/org/pld/hsm/models/sfwmm`), indicates that for Everglades National Park, the SFWMM in general matches field data reasonably well. Obviously in a regional-scale model some points will calibrate better than others. Also the 2-mile by 2-mile scale of the model may not capture field-scale variability within a single cell - a point to remember when comparing field data with model output. This concern was raised in the context of model estimates of stage in the region of S-332B. Specific calibration/validation matches for the 2 gages closest to S-332B are given in Table 1.

Table 1. SFWMM Calibration/validation statistics for selected gages.

Gage		R^2	MSE	Bias
NP206	Calibration 1979-1990	0.741	0.467	0.217
	Validation 1991-1995	0.812	0.530	0.348
RUTZKE	Calibration 1979-1990	0.753	0.153	0.141
	Validation 1991-1995	0.513	0.581	0.510

Concern 2. Appropriate application of SFWMM

> "We (ENP, FWS) believe that the SFWMM is not an appropriate tool for predicting those stages and that more local scale modeling, combined with analysis of data collected at the site is a more appropriate approach for predicting the effectiveness of the S-332B detention basin on water levels in sparrow habitat F. We also would expect that the SFWMD would agree that the SFWMM model results should not be used to interpret local scale effects such as the effect of S-332B detention area levee heights and areas on stages in sparrow habitat F. We are requesting that you provide us (FWS, ENP, USACE) with a statement from the SFWMD regarding the proper use of the SFWMM in this application."
>
> *Mitchell, December. 19, 2000. (Attachment 4)*

It is extremely important to keep in mind the particular purpose of applying the SFWMM for evaluating stages at S-332B. Due to the explicit nature of the SFWMM and the much smaller size (<25% of 2x2 mile grid size) of these reservoirs, it is not appropriate to use the SFWMM to estimate daily stages in these small scale reservoirs (see Tarboton and Santee, December 8, 2000. Attachment 3). In general, the SFWMM is appropriate for predicting the effect of water pumped into a particular model cell on adjacent model cells. The model was calibrated using stages in a single cell to match observed gage stages. The use of indicator regions and performance measures (with weekly averages of daily model estimates) increases certainty (reduces numerical errors, Lal, 2000) in the model estimates. It is appropriate to use the SFWMM to evaluate effects of S-332B pumping into a model cell on the adjacent sparrow habitat in indicator region F and nearby habitat in indicator regions C and E.

Department of Interior concerns on this same issue are expressed in the January 2, 2001 Planning Aid Letter as follows:

> "Reliability of South Florida Water Management Model (SFWMM) Results.
>
> As noted in our May 24, 2000 PAL, SFWMM results for ISOP alternatives in subpopulation E and F areas appeared promising at first glance, but serious questions regarding the reliability of SFWMM results in this area remained."
> "While this most recent SFWMM modeling (including ISOP9db28) suggests that an additional retention area may significantly improve ISOP performance in the subpopulation E and F habitats, hydrologic experts for ENP and SFWMD agree that the 2x2 mile scale of the SFWMM makes this model an insufficient tool with which to asses several aspects of the Corps' ISOP 2001/IOP proposal. These experts have stated to the Service that the SFWMM cannot reliably estimate water levels in the retention area(s),

water levels in sparrow habitats directly adjacent to the retention area(s), or the magnitude and frequency of expected surface water spillover from the retention area(s) into sparrow habitat. As explained in our June 21, 2000, letter to Mr. Richard Bray of the Florida Department of Environmental Protection, these factors have the potential to significantly affect sparrow habitats and sparrow nesting success in subpopulation E area. Therefore, reliable information on expected values for these parameters is essential to the Service's ability to fully evaluate, and potentially concur with the Corps' ISOP/IOP proposals, including construction of an additional S332B retention area. Since we have been advised by both ENP and SFWMD experts that the SFWMM results cannot be used to reliably answer these questions, we must turn to other information sources. "

Finnerty and Forsyth, January 2, 2001 (Attachment 5)

I concur that the SFWMM should not be used to estimate water levels in the retention area on a daily basis, nor the magnitude or frequency of expected spillover from the retention area into the sparrow habitat on a daily basis. It is however very appropriate to use the SFWMM as a planning tool for longer term hydrologic quantification such as weekly average pumpage into the retention area, spillover from the retention area, and weekly to annual or long term (31-year) average impacts on the sparrow habitats. I would assume that the SFWMM was used in the Corps' ISOP 2001/IOP proposal to evaluate these kind of questions rather than to estimate daily stages in the detention area or daily spillover. The SFWMM is a sufficient tool for this type of evaluation. On this point I would like to add a quote from the peer review of the model documentation:

"the SFWMM is the best available tool to address regional water management issues in South Florida"

"the level of detail incorporated in the various hydrologic components is consistent with the regional scope and the temporal scale of the model. The level of detail, particularly in the physical and hydrologic components, generally exceeds that of most other regional scale models known to us."

(Loucks et al., 1998. P 11)

I would like to express my disagreement with the following statement from the Planning Aid Letter.

"It is our understanding that most hydrologists familiar with these questions agree that the MODBRANCH model, which provides results on a far more detailed scale than does the SFWMM, is the preferred method for this kind of analysis. We further understand from you and your staff that Corps' efforts to model ISOP operations with MODBRANCH have not been successful so far, so the Corps intends to proceed with NEPA analysis of ISOP and IOP implementation using only SFWMM results. However, ENP staff has had success applying MODBRANCH to this question, and have provided some preliminary results to other agencies."

Finnerty and Forsyth, January 2, 2001 (Attachment 5)

I think many hydrologists, particularly those with experience with the application of the South Florida Water Management Model, would disagree that the MODBRANCH model is the preferred method for this kind of analysis. One of MODBRANCH's limitations is its weakness in simulation of overland flow due to its use of groundwater equations to do so. It is my understanding that the Corps' has been trying to apply the MODBRANCH model to this area for several years and has had limited success with calibration and validation of the model. I would like to see MODBRANCH calibration and validation results and a review of the modeling before passing judgement.

General statements like the one below, made in the summary of the Department of Interior Planning Aid Letter are not constructive.

> "2. Hydrologic experts from the SFWMD and ENP agree that current modeling of ISOP9db28 cannot reliably answer remaining questions regarding whether RPA targets in subpopulations E and F can be met as envisioned in ISOP9db28."
>
> *Finnerty and Forsyth, January 2, 2001 (Attachment 5)*

In my opinion there was never any agreement between hydrologic experts from the SFWMD and ENP to this effect.

Concern 3: Scale concerns with SFWMM modeling of S-332B

ENP concerns regarding the scale of the SFWMM have been expressed in a document entitled "Scale concerns with SFWMM modeling of S-332B". Although this document is undated and no author is listed, according to Punnett (Febuary 15, 2001. Attachment 7), it appears to have been distributed to several people at an ISOP Quarterly Meeting on 22-23 January 2001. I agree with Punnett's assessment that the document "falls short of any professional conclusions" and support his request to forward the document to the USGS for independent review. I would like to address several of the concerns raised in the document.

The document implies that because the SFWMM indicates a benefit of S-332B over a 12 square mile area, this is an over-estimation of benefits to Sparrow sub-populations E and F relative to observed data analysis. I contend that the analysis of the observed data presented in the document is inconclusive and that the data could be interpreted differently as outlined by Punnett (January 15, 2001). Sensitivity analysis of the ISOP modeling and a scenario that removes the S-332B pumping from the model domain, indicates that not including the S-332B pumping would have a significant effect on Sparrow sub-populations F and a lesser effects on sub-populations C and E. Selected results of this modeling, undertaken by the Corp's at the request of the SFWMD to support this response, are attached. Figures 1-3 show that not including S-332B pumping reduced the mean annual hydroperiod in sub-population F by 15% and in each of sub-populations C and E by 2%. This implies that the inclusion of S-332B pumping in the ISOP does have the effect of increasing hydroperiods in sub-populations C, E and F. It should not seem surprising that the addition of 64,000 ac-ft/yr (on average) at S-332B would have an effect at distances of 6-8 miles away in Sparrow sub-population E. The ENP has itself stated that in other SFWMM simulations such as those undertaken for the Water Preserve Area Feasibility Study, a reduced inflow to the ENP (-45,000 ac-ft/yr by my calculations) has a "significant impact on the ENP" (January 22, 2000 memorandum from Zimmerman to Mitchell).

Concern 4. Documentation of model.

The ENP has repeatedly asked for better documentation of the SFWMM.

> "It is my opinion that the documentation that we are asking for, should have been produced as a routine part of code modification. Model results can only be properly interpreted if there is a full understanding of the modeling assumptions, and the shortcomings of the model. All models fall short of a perfect description of reality. The important point is to know how and in what way the model falls short, and to adjust the interpretation accordingly. This untimely request could have been dealt with summarily if changes in the SFWMM code were documented when they were made."

Mitchell, December 6, 2000 (Attachment 1)

I responded that,

> " SFWMD staff is not in a position to produce this documentation in the near future due to other pressing obligations. Source code and sample input files for this version of the model were put on an FTP site on August 24, 2000. Tom Van Lent of the ENP was made aware via email on Aug. 31, 2000 of the location of this model code and input. Furthermore a CD containing the source code, input files for the calibration/validation runs and all the common data needed to make simulations using this version of the model was given to the ENP on September 28, 2000. The best documentation is the code itself."
>
> *Tarboton and Santee, December 8, 2000 (Attachment 3)*

Clearly there is a need to document more specifically the appropriate and inappropriate uses of the SFWMM and document modifications to the model. South Florida Water Management District staff is committed to documenting the model development we undertake. It is not always possible to do this in the timeframes required by other agencies because of our own priorities. Ideally we would like to withhold the release of any code to others until we have had the chance to fully document modifications. In the spirit of mutual collaboration and to try to assist in making new code available early, we have released code without full documentation. As was noted earlier, the MODBRANCH modeling undertaken by the ENP has not, to my knowledge, been documented yet.

In conclusion I would like to suggest that technical issues and questions regarding modeling be brought to the model developers prior to airing them through agency heads in the form of Planning Aid Letters. I feel this will engender a true spirit of collaboration and permit more efficient use of our resources in our mutual effort towards Everglades Restoration.

Sincerely,

Ken Tarboton, Ph.D., P.E.
Sr. Supervising Engineer
Hydrologic Systems Modeling Department
Water Supply Division
South Florida Water Management District

KT/nm
Attachments (7)
c: Jayantha Obeysekera, SFWMD
Ken Ammon, SFWMD
Naomi Duerr, SFWMD
Ray Santee, SFWMD
Dave Sikkema, ENP
Heather McSherry, FWS
Mike Zimmerman, ENP
Richard Punnett, USACE

References

Lal, Wasantha, A. M., 2000. "Numerical errors in groundwater and overland flow models", Water Resources Research, 36(5), pp. 1237-1247.

Loucks, D.P., Graham, W.D, Heatwole, C.D., Labadie, J.W. and Peralta, R.C. 1989. Review of Documentation of South Florida Water Management Model. [http://iweb/iwebB501/wsd/hsm/models/sfwmm/index.html]

SFWMD (1999) A Primer to the South Florida Water Management Model (Version 3.5). Hydrologic Systems Modeling Division, Planning Department, South Florida Water Management District, West Palm Beach, Florida. [http://www.sfwmd.gov/org/pld/hsm/models/sfwmm]

Attachment 1: Mitchell Dec 6, 2000

To: Heather McSharry
Cc: Kevin Kotun, Dave Sikkemma, Freddie James, Ken Tarboton, Richard Punnett
From: Sherry Mitchell-Bruker, Everglades National Park
Re: ISOP S-332B detention area modeling
Date: 12-06-00

This is follow-up on the conference call with Ken Tarboton, Ray Santee,(SFWMD) Richard Punnett, Lan Do,(USACE) Kevin Kotun and Sherry Mitchell (ENP) on 12-05-00. The questions posed by ENP were:

1. How was the S-332B detention area modeled in the SFWMM?
2. Clarify how mass balance is treated in the S-332B calculations.
3. Explain why some simulations have a 10' head in the cell when the detention area weir crest is at 8.3'.
4. How does maintaining a head at 8' in the entire 4 square mile cell below the detention area (C15R24) relate to the actual situation where an 8' stage in the detention area corresponds to measured stages in the cell (6' stages at G-3437 and 6.5' stages at RG-3)?

The discussion on the conference call centered on answering the first three questions. Ray Santee provided some explanation of the methods used to model the detention area targets, overflow and cell, but was unclear on several key points. Some calculations outside of the conventional finite difference numerical scheme had been used to determine weir overflow and possibly the stage that determined cell to cell fluxes. Santee was uncertain whether the stage to calculate cell to cell fluxes was calculated from the detention area equations or from the stage computed from the pre-existing finite difference scheme. Kevin Kotun suggested that Ray provide the park with a flow diagram and equations to explain the modeling procedure. Ken Tarboton indicated that the SFWMD had other commitments and could not commit to a rapid response to the request for written documentation. Richard Punnett stated that all of the modeling questions had been clarified, the model results were clean and ENP had all of the information needed to proceed with their analysis. Sherry indicated that ENP scientists would not be able to interpret the ecological impacts of the modeling without a clear description of what had been done in the model. She further stated that ENP's ability to meet the Dec 20 deadline for an agreement on S-332B would depend on the SFWMD timely delivery of the documentation of the S-332B modeling scheme. Richard commented that ENP had these model results for 3 months and that it was unreasonable to expect the SFWMD to respond to our deadline at this late juncture. Ken indicated that he would consult his management for guidance on setting the priorities for this assignment.

I would like to add to this summary some comments regarding SFWMM documentation. As co-chair and acting co-chair of the Model Refinement Time, both Ken Tarboton and Sherry Mitchell have recognized the need to fully document modeling used to simulate restoration efforts. It is my opinion that the documentation that we are asking for, should have been produced as a routine part of code modification. Model results can only be properly interpreted if there is a full understanding of the modeling assumptions, and the shortcomings of the model. All models fall short of a perfect description of reality. The important point is to know how and in what way the model falls short, and to adjust the interpretation accordingly. This untimely request could have been dealt with summarily if changes in the SFWMM code were documented when they were made.

Attachment 2: Punnett Dec 6, 2001

Subject: Correction to Re: ISOP S-332b modeling
Date: Wed, 6 Dec 2000 14:42:00 -0600
From: "Punnett, Richard E SAJ" <Richard.E.Punnett@saj02.usace.army.mil>
To: Sherry_Mitchell@nps.gov, Dave_Sikkema@nps.gov, Kevin_Kotun@nps.gov, Freddie_James@nps.gov, ktarbot@sfwmd.gov, Heather_McSharry@fws.gov, "Do, Lan V SAJ" <Lan.V.Do@saj02.usace.army.mil>, "Choate, Michael L SAJ" <Michael.L.Choate@saj02.usace.army.mil>, "Bullock, Susan A SAJ" <Susan.A.Bullock@saj02.usace.army.mil>

Greetings all,

I wanted to clarify a misquote in the synopsis provided by Sherry: "Richard Punnett stated that all of the modeling questions had been clarified, the model results were clean and ENP had all of the information needed to proceed with their analysis." I firmly believe that all our modeling questions will never be answered (I mean this sincerely, it's neither snide nor accusatory).

The points I made were these:

1. The model runs that do not have the weir overflow appear to be both stable and reasonable. The weir overflows runs show oscillations that can be expected with daily timesteps, but the averages appear good.

1. The ENP and Corps has had the modeling source code for 3 months -- the task to explain the code should not fall on the SFWMD at the moment we most want it.

2. The ENP has the same modeling information that the Corps has.
4. The ENP should consider completing the evaluations since it is unlikely that all their questions will be answered in time to meet the Dec 20 deadline.

The new points I would offer here are:

1. No one understands, to the level of detail we approached in our conversations, how each routine in the SFWMM (or MODBRANCH for that matter) is processed. 2. If my choice is to wait until every part of a model is fully documented before I use it, I would have no models to run (i.e. my work would be easier).

3. We all recognize that we use the best available model and that changes and improvements will happen.
4. I would like to emphasize number 4 from above: The ENP should consider completing the evaluations since it is unlikely that all their questions will be answered in time to meet the Dec 20 deadline. This should be done for three reasons: 1) Runs with the reservoir have already been evaluated; and 2) the Corps would like to know what DOI thinks of the performance results (even if you have not satisified all your questions concerning the modelling processes); and 3) the deadline for consensus is real (driven by CEQ requirements).

Thanks. See many of you at GEER...

Attachment 3: Tarboton and Santee, December 8, 2000

Subject: S-332B Conference call follow up
Date: Fri, 08 Dec 2000 13:48:21 -0500
From: Ken Tarboton <ktarbot@sfwmd.gov>
Organization: South Florida Water Management District
To: Sherry Mitchell <Sherry_Mitchell@nps.gov>,
Kevin Kotun <Kevin_Kotun@nps.gov>,
Richard.E.Punnett@saj02.usace.army.mil,
"Do, Lan" <Lan.V.Do@SAJ02.usace.army.mil>
CC: Dave Sikkema <Dave_Sikkema@nps.gov>,
Freddie James <Freddie_James@nps.gov>, Heather_McSharry@fws.gov,
Ray Santee <rsantee@sfwmd.gov>,
Jayantha Obeysekera <jobey@sfwmd.gov>, Raul Novoa <rnovoa@sfwmd.gov>

This is a follow up to the conference call on 12/5/00 to discuss modeling of S-332B detention area in the SFWMM v3.8.1. Participants were Richard Punnett and Lan Do from USACE, Sherry Mitchell and Kevin Kotun from ENP and Ray Santee, Raul Novoa and Ken Tarboton from SFWMD.

Discussion focused on explanation of methods used to model the S332B detention area. There were seveal specific questions that still needed answering as a result of the conference call. These are answered below.

1. ENP staff asked for clarification of whether cell to cell fluxes were calculated from the estimate of stage in the detention area or from the estimate of stage in the cell.

SFWMD staff can can now confirm that cell to cell fluxes are determined using the stage in the cell, not those estimated for the detention area.

2. ENP staff asked for the SFWMD to provide documentation in the form of a flow diagram and equations to explain the modeling procedure.

SFWMD staff is not in a position to produce this documentation in the near future due to other pressing obligations. Source code and sample input files for this version of the model were put on an FTP site on August 24, 2000. Tom Van Lent of the ENP was made aware via email on Aug. 31, 2000 of the location of this model code and input. Furthermore a CD containing the source code, input files for the Calibration/validation runs and all the common data needed to make simulations using this version of the model was given to the ENP on September 28, 2000. The best documentation is the code itself. Reservoir processes are in the main.F, staout.F, stastor.F, and wroute.F subroutines. It is suggested that ENP staff refer to these subroutines for complete documentation.

3. ENP staff sought clarification on why estimated heads in the detention area were at 10' when the weir crest was at 8.4'.

In the ISOP9db simulation the USACE used an import target stage of 10' for The S332B detention area and a weir crest elevation of 8.4'. Target stage is Used to estimate the available storage in the detention area to restrict S332B pump inflow to the detention area. ENP staff pointed out oscillation in stage in the detention area with some times of frequent oscillations between 8-10'. The model is explicit with a daily time step so oscillations from day to day in the estimation of stage in a small reservoir are not unlikely. This is because the S332B detention area is 160 acres, much smaller than the 2x2 mile (2560 acres) resolution of the SFWMM. Furthermore, outflow from the detention area is to the grid cell within which it is simulated and the magnitude of other processes (surface water flow, regional groundwater flow and levee seepage) are reltively large. Hence in this case, results of stage estimates in the detention area should be interpreted with caution and good judgement. An alterntive way to simulate this situation would be to model the detention area without an emergency outlet to determine the time stage is above any crest elevation to get an estimate of the time the crest would have overflowed.

4. ENP staff asked how maintaining a head at 8' in the entire 4 square mile cell related to 8' stages in the detention area and measured stages in the field.

This question is not clear to SFWMD staff. Our examination of output for the ISOP9db simulation from ftp://ftp.sfrestore2.org/pub/upload/lan/daily_stg_minus_lsel.bin shows that model simulated stages in R15C24 never exceed 8' and were above 7' approximately 5 percent of the time. The cell was only ponded approximately 12 percent of the time. Note that the grid cell stages output from the model for the cell with a reservoir within it, reflect the volume of water in that cell spread over the entire cell, not the tailwater stage that would be used for calculations of flow from the reservoir to the cell.

I trust this meets your needs,

Ken Tarboton & Ray Santee

Ken Tarboton
Senior Supervising Engineer
Hydrologic Systems Modeling
Water Supply Division

Attachment 4: Mitchell, December 19, 2000.

Subject: Re:Your Telephone Request
Date: Tue, 19 Dec 2000 17:52:39 -0500
From: Sherry_Mitchell@nps.gov (Sherry Mitchell)
To: "Ken Tarboton" <ktarbot@sfwmd.gov>
CC: Jayantha Obeysekera <jobey@sfwmd.gov>, Luis Cadavid <cadavid@sfwmd.gov>, Randy VanZee <rvanzee@sfwmd.gov>

Ken,

Thanks for your timely response to my request.

As you know, we have had numerous discussions between the park, the Corps, FWS and SFWMD regarding the application of the SFWMM to the Interim Operations Plan. The park has expressed concern that the model results from the SFWMM are quite different than the hydrology observed in the field. We have heard statements from you and from Ray to the effect that this is the result of trying to obtain local detail from a regional scale model. It is our understanding that the SFWMD has always been careful to state that the SFWMM is a regional planning model and that output from the model should be evaluated appropriately. (I think I recall from the RET meetings that you are most comfortable with a 4 cell average).

The application of the SFWMM to the Interim Operations is intended to address the efficacy of the operational plan on the Cape Sable Seaside Sparrow Habitat. Some of that habitat, specifically population F, is adjacent to the S-332B structure and therefore it is essential to have a realistic simulation of the effect of the 332-B pump station and detention basin on the stages within that habitat. We (ENP, FWS) believe that the SFWMM is not an appropriate tool for predicting those stages and that more local scale modeling, combined with analysis of data collected at the site is a more appropriate approach for predicting the effectiveness of the S-332B detention basin on water levels in sparrow habitat F. We also would expect that the SFWMD would agree that the SFWMM model results should not be used to interpret local scale effects such as the effect of S-332B detention area levee heights and areas on stages in sparrow habitat F. We are requesting that you provide us (FWS, ENP, USACE) with a statement from the SFWMD regarding the proper use of the SFWMM in this application.

Thanks for your cooperation,

Happy Holidays!

****
Sherry Mitchell-Bruker, Ph.D.
Research Hydrologist
Everglades National Park
40001 State Road 9336
Homestead, FL 33034-6733

Phone: 305-242-7886
****

Attachment 5: Finnerty and Forsyth, January 2, 2001.

United States Department of the Interior

National Park Service
Everglades National Park
4001 State Road 9336
Homestead, FL 33034

Fish and Wildlife Service
Office of the State Supervisor
1339 20th Street
Vero Beach, FL 32960-3559

January 2, 2001

Colonel James G. May
District Commander, Jacksonville District
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Colonel May:

The Department of the Interior (Department) has prepared this Planning Aid Letter (PAL) for the Interim Operations of the Central and Southern Florida (C&SF) Project to Protect the Cape Sable Seaside Sparrow Until the Modified Water Deliveries to Everglades National Park (ENP) project is fully constructed, otherwise know as the Interim Operating Plan (IOP). Development of the IOP is closely related to development of Interim Structural and Operational Plan (ISOP) 2001 operations. Accordingly, this PAL is intended to apply to both projects. The South Florida Water Management District (SFWMD) is the local sponsor for these projects. Information presented below was developed in a series of meetings and other communications between the Fish and Wildlife Service (Service), the National Park Service, ENP, and the Corps of Engineers (Corps). This PAL is provided in accordance with the Fish and Wildlife Coordination Act (FWCA) (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*) and section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). This PAL does not constitute the report of the Secretary of the Interior as required by section 2(b) of the FWCA, nor does it constitute a biological opinion under section 7 of the ESA. Due to anticipated changes in alternative design as the participating agencies evaluate elements of the IOP, the positions of the Department in this and any subsequent PALs are subject to change.

This PAL focuses on recommendations based on our analysis of structural and operational components modeled in a series of model runs called ISOP9db1-28. These runs were developed in an effort to devise an alternative that will provide the hydrologic equivalent of the exact provisions of the Reasonable and Prudent Alternative (RPA) presented in the Service's February 19, 1999, Biological Opinion (BO) for the endangered Cape Sable seaside sparrow (sparrow) in all sparrow habitats. We understand from members of your staff that ISOP9db28 will be the Corps' preferred alternative in upcoming National Environmental Policy Act (NEPA) documentation. Because information on the ISOP9db28 alternative was received very recently, our staffs have not completed a full analysis of this particular run. However, we have completed an analysis of the previous model run, ISOP9db24 and, based on descriptions provided by your staff, we assume for purposes of this PAL that ISOP9db28 results will be similar. A more detailed discussion of our analysis of modeled alternatives and the ecological basis for our recommendations will be provided in an FWCA Report, to be prepared subsequent to your publication of a draft Environmental Impact Statement for the IOP.

We are pleased to note that significant progress on this project has been accomplished since our May 24, 2000, PAL. ISOP9db28 appears to meet RPA targets for subpopulations A, B, C and D. Remaining issues center on efforts to provide the hydrologic equivalent of RPA targets in the subpopulation E and F areas without releasing additional water into Northeast Shark River Slough. Our comments are provided below by area.

Western Shark Slough - subpopulation A

As documented in our November 2, 2000, letter to you, the Service has concluded that the best currently available scientific and commercial information indicates that the Corps' ISOP 2001 proposal for S12, S343 and S344 operations (as modeled in ISOP9db28 and several other runs) will fulfill the February 19, 1999, RPA's requirement for the subpopulation A. This represents a significant improvement in the likelihood of successful nesting for the sparrow, and resolution of difficult and long-standing policy and technical questions.

We are hopeful that this set of operations will continue to be part of your preferred alternative for the ISOP and IOP. However, Mr. Richard Punnett of your staff has indicated that some Corps staff have expressed reservations regarding effects these operations may have on structural integrity of the C&SF Project works during high water periods. If modifications to the current proposal are indeed necessary, Service evaluation of any changes would require additional modeling runs to ensure that subpopulation A habitat areas would not be adversely affected. Any such changes would have to be re-evaluated for compliance with RPA requirements.

Subpopulations B,C and D

Operational modifications included in ISOP9db28 and several similar runs appear to have addressed the concerns we identified for the subpopulation C and D areas in our May 24, 2000, PAL. Both breeding habitat availability and hydroperiod frequencies appear to closely match conditions expected under the exact provisions of the RPA, and should provide for some habitat improvement in the subpopulation C and D areas. Hydrologic conditions in the subpopulation B area did not change significantly under any of the alternatives, as expected.

We are hopeful that ISOP performance in these habitat areas will continue to meet RPA targets as further modifications are made in other areas. However, it is possible that resolution of issues discussed below surrounding operations of the S332B pump and retention area(s) may lead to changes in the volume and/or timing of flows moving towards downstream structures that would alter expected performance in the subpopulation C and D habitat areas. Any such changes would have to be re-evaluated for compliance with RPA requirements.

Subpopulations E and F

1. Reliability of South Florida Water Management Model (SFWMM) Results.

As noted in our May 24, 2000, PAL, SFWMM results for ISOP alternatives in the subpopulation E and F areas appeared promising at first glance, but serious questions regarding the reliability of SFWMM results in this area remained. Since our previous PAL, SFWMD staff have revised the SFWMM model to better represent the S332B pump and retention area(s). This revised model produced much reduced estimates of hydroperiod and water level increases in the subpopulation E and F habitats resulting from S332B operations, suggesting that the ISOP 2000 operations actually fell far short of their intended targets. This and other evidence led to modeling of an additional retention area and revised operations for S332B in an attempt to ensure that ISOP 2001 and IOP operations would meet the RPA targets.

While this most recent SFWMM modeling (including ISOP9db28) suggests that an additional retention area may significantly improve ISOP performance in the subpopulation E and F habitats, hydrologic experts from ENP and SFWMD agree that the 2x2 mile scale of the SFWMM makes this model an insufficient tool with which to assess several aspects of the Corps' ISOP 2001/IOP proposal. These experts have stated to the Service that the SFWMM cannot reliably estimate water levels in the retention area(s), water levels in sparrow habitats directly adjacent to the retention area(s), or the magnitude and frequency of expected surface water spillover from the retention area(s) into sparrow habitat. As explained in our June ~~21~~, 2000, letter to Mr. Richard Bray of the Florida Department of Environmental Protection, these factors have the potential to significantly affect sparrow habitats and sparrow nesting success in much of the subpopulation F area, and may also influence expected conditions in the subpopulation E area. Therefore, reliable information on expected values for these parameters is essential to the Service's ability to fully evaluate, and potentially concur with, the Corps' ISOP/IOP proposals, including construction of an additional S332B retention area. Since we have been advised by both ENP and SFWMD experts that the SFWMM results cannot be used to reliably answer these questions, we must turn to other information sources.

2. Other available information

It is our understanding that most hydrologists familiar with these questions agree that the MODBRANCH model, which provides results on a far more detailed scale than does the SFWMM, is the preferred method for this kind of analysis. We further understand from you and your staff that Corps' efforts to model ISOP operations with MODBRANCH have not been successful so far, so the Corps intends to proceed with NEPA analysis of ISOP and IOP implementation using only SFWMM results. However, ENP staff have had success applying MODBRANCH to this question, and have provided some preliminary results to other agencies.

These results, along with an analysis of actual data collected during operations of the S332B pump and retention area this year (provided to the Corps via a July 19, 2000, e-mail message from Dr. Thomas Van Lent of ENP to Mr. Dennis Duke) suggest that S332B could be operated, using different operations than any proposed by the Corps so far, in a way that would push enough water into the subpopulation E habitat to meet RPA targets there. However, in providing the hydrologic head necessary to push water to subpopulation E, areas of subpopulation F habitat near the retention area(s) would experience much longer hydroperiods and deeper water depths than called for in the RPA. Available information suggests that these depths and hydroperiods would cause the vegetation in a significant portion of the subpopulation F habitat area to convert to a composition unsuitable for the sparrow, and may also prevent or interrupt sparrow breeding in these areas in wet years. MODBRANCH modeling of S332B operations proposed by the Corps suggests that similar flooding of subpopulation F habitat will occur under ISOP 2000, ISOP9db28 and similar proposals.

Therefore, the best scientific information available to the Service at this time indicates that ISOP9db28 will not provide the hydrologic equivalent of RPA requirements outlined in our BO for both subpopulations E and F. Further, available evidence suggests that operations of this kind may cause additional taking of sparrows and additional adverse modification of sparrow critical habitat in subpopulation F, above and beyond incidental taking anticipated in the February 19, 1999, incidental take statement. Currently available information continues to indicate that the best method for reaching RPA targets in the subpopulation E and F areas is a simultaneous increase in discharges to Northeast Shark Slough coupled with a much broader front to limit seepage from the park than is currently being provided by the IOP/ISOP features.

We are confident that detailed MODBRANCH modeling developed through a cooperative Corps/Service/ENP/SFWMD effort can enhance our current understanding of the efficacy of the S332B pump and retention area(s), and hopefully provide the reliable information necessary for us to complete section 7 consultation on construction of a new S332B retention area and concur with ISOP9db28 or a similar proposal in the future. Until such an effort can be completed, we are concerned that current ISOP 2000 South Dade Conveyance System (SDCS) operations are not meeting RPA targets in subpopulations E and F, thereby continuing jeopardy conditions in these areas into a sixth year. In order to alleviate this continuing impact to the sparrow and to limit the Corps' possible legal liability as much as is possible given current policy constraints, we recommend that the Corps immediately implement Test 7 Phase II operations in the SDCS, as modeled in RPA102 and continue these operations until agreement can be reached on another set of operations.

3. Additional issues

Two additional issues affect analysis of ISOP/IOP performance in the subpopulation E area. First, ISOP/IOP modeling results must be compared against a modeled simulation of the exact RPA requirements. For the subpopulation E area, our agencies have agreed that the RPA130 run represents the RPA requirements. However, information provided on the Corps' web site does not allow direct comparison of RPA130 with ISOP9db28 or similar runs. Mr. Punnett recently agreed to revise the web site information to provide these comparisons, but they are not available currently. These comparisons will need to be provided prior to initiation of our work on an FWCA Report for the IOP.

The second issue is capacity of the S333 structure. As noted in our May 24, 2000, PAL, the simulations provided by the Corps show that the imposed constraint of 1,350 or 1,450 cubic feet per second (cfs) at S333 affects flows into Northeast Shark Slough about half of the years. This constraint significantly affects the RPA simulations and the degree to which the RPA's 30 percent, 45 percent, and 60 percent targets for regulatory releases into Northeast Shark Slough are achieved.

The BO recognizes that some limit to flow through S333 exists. However, in our view, restrictions to flow at S333 are imposed by either (a) the physical limits of the structure to pass flows (such as structure size and construction, available water, head differences across the structure, and getaway capacity); or (b) constraints imposed by conditions or operations that would threaten or compromise the integrity of the structure. The Corps chose 1,350 cfs as the upper limit not because of the above reasons, but because that was what the structure was designed to pass. This would, therefore, be a conservative estimate of the physical limits of the structure. Tests demonstrate flows could easily exceed 1,450 cfs, and the highest observed flow was 1,580 cfs. The Corps and SFWMD, during the Modified Water Deliveries conveyance simulations, modeled sustained flows of 2,000 to 2,500 cfs. This was based upon the physics of flow and observed flow measurements, and SFWMD has provided information suggesting flows in this range will not compromise structural integrity. We accept this as a reasonable analysis on the physical limits of the structure. However, we acknowledge that Corps staff disagree with some aspects of this assessment and believe that S333 cannot safely pass more that 1,350 cfs without reinforcement. Mr. Dennis Duke of your staff has stated to us that the Corps will consider installation of rip-rap or other structural reinforcement in order to increase S333 capacity. We urge the Corps to include these measures in all ISOP/IOP alternatives.

Summary and recommendations

1. Significant progress has been achieved since our May 24, 2000, PAL. ISOP9db28 appears to meet RPA requirements for subpopulations A, B, C and D.

2. Hydrologic experts from the SFWMD and ENP agree that current modeling of ISOP9db28 cannot reliably answer remaining questions regarding whether RPA targets in subpopulations E and F can be met as envisioned in ISOP9db28.

3. MODBRANCH modeling and analysis of ISOP 2000 operations performed by ENP experts suggest that ISOP9db28 operations will not meet RPA requirements in subpopulations E and F. Therefore, the Service is not able to concur with ISOP9db28, or

similar proposals that include use of the S332B pump and retention area(s), for subpopulations E and F at this time.

4. The Service recommends that Corps, SFMWD and ENP experts work together to expeditiously model ISOP operations using the MODBRANCH model, in hopes that this more detailed and more reliable information can be used to develop an ISOP proposal that will meet all RPA targets. This effort should be completed prior to development of NEPA documentation for the IOP.

5. IOP alternatives should include structural reinforcement of the S333 structure in order to maximize capacity.

6. Until concurrence on an ISOP alternative can be achieved, we recommend that the Corps immediately implement Test 7 Phase II operations in the SDCS, as modeled in RPA102.

We continue to appreciate the hard work and long hours invested by many members of your staff in this effort and are hopeful that concurrence will be possible in the near future. For further information or assistance, please contact Dave Sikkema at (305) 242-7814 or Heather McSharry at (561) 562-3909, extension 247.

Sincerely yours,

Maureen Finnerty
Superintendent
Everglades National Park

Stephen W. Forsythe
State Supervisor–Ecological Services
Fish and Wildlife Service

cc:
Assistant Regional Director, Ecological Services, Service, Atlanta, Georgia
Executive Director, South Florida Water Management District, West Palm Beach, Florida
Florida Dept. of Environmental Protection, Tallahassee, Florida
Florida Dept. of Agriculture and Consumer Services, West Palm Beach, Florida
Miccosukee Tribe, Miami, Florida
Seminole Tribe, Hollywood, Florida
Miami-Dade County DERM, Miami, Florida
Field Supervisor, Service, Vero Beach, Florida
Florida Fish and Wildlife Conservation Commission, Vero Beach, Florida

Attachment 6: May, January 22, 2001.

January 22, 2001

Executive Office

Ms. Maureen Finnerty
Superintendent, Everglades National Park
40001 S.R. 9336
Homestead, Florida 33034

Mr. Steve Forsythe
Florida State Supervisor
U.S. Fish and Wildlife Service
1360 U.S. Highway 1
Suite 5, P.O. Box 2676
Vero Beach, Florida 32961

Dear Maureen and Steve:

I have received your "Planning Aid Letter" (PAL) for the Interim Operating Plan (IOP) for the Central and Southern Florida (C&SF) project to protect the Cape Sable Seaside Sparrow (sparrow). I enclose a letter dated December 25, 2000 from the President's Council on Environmental Quality setting forth special arrangements for NEPA compliance in carrying out ISOP operations in the coming year and giving me instructions on the implementation of the Interim Structural and Operational Plan-2001 (ISOP) and IOP.

Before I address your letter, I must say that I enjoyed seeing you both at the Everglades Coalition. The meeting was another step in my orientation as the commander of the Jacksonville District. This orientation, as you would expect, has included a serious review of the record of the Jacksonville District's past actions and interagency dialog as well as candid conversations with my predecessors in command. From that review I am aware of the often difficult and contentious debates that have often been the defining character of our relationship with your agencies.

As a relative newcomer to this process, I believe the record reveals a clear pattern for those disagreements and points to a clear remedy. I think it is important to discuss that so we can achieve more productive professional relationships in the future. The record reveals that when my predecessors have asked you for biological opinions and information on how our actions might affect the resources within your areas of organizational responsibility, your response has frequently been expressed in terms of "required" hydrologic actions for water managers at the Corps and South Florida Water Management District. That "required" action is often based not just on biology or the physical requirements of lands you control, but on other disciplines outside your area of organizational expertise such as water management of the Central and Southern Florida project, and construction project design and execution.

My predecessors have studiously avoided publicly discussing the specific flaws in your "opinions" and "recommendations" when they venture outside the area of your organizational expertise and into the area of water management and, as a general rule, I will do the same. In this first instance during my command, however, I would like to illustrate my concern in the context of your "Planning Aid Letter" to point out what we must overcome…and I am determined to overcome…if we are to save not just the sparrow but the entire ecosystem in South Florida.

In the letter you state that, while the Corps' ISOP/IOP plan appears to meet the needs of the sparrows in subpopulations A, B, C and D, you are not certain about the proposal as it relates to meeting the hydrologic needs of the sparrows in subpopulation E and F. You raise the issue of releasing additional water into Northeast Shark River Slough, which you acknowledge is not an available option until the necessary private property rights are acquired and construction completed on features necessary to protect landowners and farmers from adverse impacts due to increased flows in the slough. I am aware that the Department of the Interior acquisition efforts in the Park Expansion Area may soon expand our options and encourage you to proceed with those efforts. It appears that your real reservations with the ISOP/IOP rest, not on biology, but rather on your hydrologic determinations. You state that there are "serious questions" regarding the reliability of the South Florida Water Management Model (SFWMM) as a tool for predicting water levels in the areas where subpopulations E and F reside. You further state that "hydrologic experts" from ENP and SFWMD agree that the 2x2 mile scale of the SFWMM make this model an insufficient tool with which to assess several aspects of the Corps' ISOP 2001/IOP proposal. You suggest the MODBRANCH model provides a better basis for analysis and that ENP staff, in your view have had success with this model. You conclude that ENP's hydrologic opinions represent the "best scientific information available", the Corps effort is incorrect and may, on the basis of unspecified "available information", cause "additional taking of sparrows and additional adverse modification of sparrow habitat." Your observations provide, in my opinion, the perfect illustration of what has gone wrong between our agencies for the last several years.

As I am charged to make decisions taking into account your comments on matters within your expertise I am forced to struggle with the following questions in making my decision. Given the fact that there are still outstanding issues that affect our confidence in the results generated by MODBRANCH (which we are all working to overcome), should I delay my efforts to protect the sparrow until perfection of the model or proceed on the basis of the best reliable hydrologic data I have? The SFWMM was, after all, sufficiently detailed for use in drafting your biological opinion and the recommendations based on it. How can I be sure that the biological opinion you wrote for the sparrow with its goal of quickly implementing the Modified Water Deliveries Project is still valid since it was designed using less refined data than that contained in the SFWMM? You recommend the Corps revert to the old Test 7 Phase II operations but if SFWMM is not a valid tool, how can I be sure that will produce hydrology that is good for the sparrow? Since the U. S. Fish and Wildlife Service (Service) has no expertise in water management, how are they qualified to conclude that the Corps is not the source of the "best available" hydrologic information on system the Corps designed, built and oversees in terms of operations?

I don't raise these problems with your "Planning Aid Letter" to be critical of you or your respective staffs. I do want to illustrate the difficulty the Corps continues to experience when the biological information we need from your agencies is interspersed with uncoordinated hydrologic assumptions. You state that SFWMD experts and your staff feel a more precise model is needed to analyze all aspects of the ISOP/IOP. While I certainly agree that, as a general rule, the greater the resolution of a hydrologic model the more useful it is, my experts indicate that while we have made progress, the MODBRANCH model is still not ready for use. While I agree with your statement that detailed MODBRANCH modeling developed through interagency cooperation could provide reliable information in due course, as the person charged with making modifications to the Central and Southern Florida Project operations plans in light of the fact that the recovery of an endangered species would be assisted by my immediate action, I simply cannot wait until all the technical issues surrounding MODBRANCH can be adequately addressed. I feel I must proceed with the only valid technical information currently available. The SFWMM is well developed and widely accepted model. It shows that the ISOP/IOP operations will meet or exceed the RPA requirements for sparrow subpopulations E and F. Indeed, although we chose to constrain our use of 332B because of water quality concerns expressed by Everglades National Park, the SFWMM modeling results indicate that ISOP 2000 met the RPA targets. In our professional judgment, 332B with the new detention area we propose can meet the "reasonable and prudent actions" the Service has stated the sparrow requires with little or no overflow into the Park.

I want you both to know that I am serious in my resolve to protect the sparrow and other endangered species while moving forward with the improved water deliveries ENP so badly needs. I am pleased that our actions over the past several years have, despite challenging weather conditions, led to overall growth of the sparrow population.

I look forward to working with you both to forge a better understanding of our respective missions. I hope that such an understanding will allow the Corps and the South Florida Water Management District to better use your expertise. That will be even more important as we turn our attention to how species, to include the sparrow, and lands within Everglades National Park are likely to react to the increasing water levels we will introduce into the system as we implement the recently authorized comprehensive restoration effort.

Sincerely,

James G. May
Colonel, U.S. Army
District Engineer

Enclosure

DE/COL May:dh

Attachment 7: Punnett February 15, 2001

To: James G May/CESAJ/SAJ02@CESAJ
cc: heather_mcsharry@fws.gov@SMTP@Exchange, dworth@sfwmd.gov@SMTP@Exchange, Cheryl P Ulrich/CESAJ/SAJ02@CESAJ, Maureen_Finnerty@nps.gov@SMTP@Exchange, Robert_Johnson@nps.gov@SMTP@Exchange, Thomas_Van_Lent@nps.gov@SMTP@Exchange, Michael E Magley/CESAD-PM/sad01@cesad, Gary M HQ02 Hardesty/USACE HQ Washington DC/ORGANIZATION@Exchange, donald_jodrey <donald_jodrey@ios.doi.gov>@SMTP@Exchange, neal.mcaliley@usdoj.gov@SMTP@Exchange, dave_sikkema@nps.gov@SMTP@Exchange, Cynthia_Dohner@fws.gov@SMTP@Exchange, Dave_Ferrell@fws.gov@SMTP@Exchange, Stephen_Forsythe@fws.gov@SMTP@Exchange, james@ever.nps.gov@SMTP@Exchange, Richard E Bonner/CESAJ/SAJ02@CESAJ, Dennis R Duke/CESAJ/SAJ02@CESAJ, Doris A Marlin/CESAJ/SAJ02@CESAJ, James M Riley/CESAJ/SAJ02@CESAJ, Elmar G Kurzbach/CESAJ/SAJ02@CESAJ, Bo Smith/CESAJ/SAJ02@CESAJ, James C Duck/CESAJ/SAJ02@CESAJ, Russ L Rote/CESAJ/SAJ02@CESAJ, Jon Moulding/CESAJ/SAJ02@CESAJ, Martin T Gonzalez/CESAJ/SAJ02@CESAJ, John M Hashtak/CESAJ/SAJ02@CESAJ, Luis A Ruiz/CESAJ/SAJ02@CESAJ, Michael L Choate/CESAJ/SAJ02@CESAJ, James W Vearil/CESAJ/SAJ02@CESAJ, Susan A Bullock/CESAJ/SAJ02@CESAJ, Christopher T Smith/CESAJ/SAJ02@CESAJ, Tracy L Hendren/CESAJ/SAJ02@CESAJ, Claudia H Hundley/CESAJ/SAJ02@CESAJ, John D Brady/CESAJ/SAJ02@CESAJ, Lloyd D Pike/CESAJ/SAJ02@CESAJ, Edward E Middleton/CESAJ/SAJ02@CESAJ, Clay Sanders/CESAJ/SAJ02@CESAJ, Christopher J Brown/CESAJ/SAJ02@CESAJ, Lan V Do/CESAJ/SAJ02@CESAJ, Robert A Evans/CESAJ/SAJ02@CESAJ, Jessica M Files/CESAJ/SAJ02@CESAJ, Edwin Brown/CESAJ/SAJ02@CESAJ, Scott B Burch/CESAJ/SAJ02@CESAJ, Doris A Marlin/CESAJ/SAJ02@CESAJ, John D Brady/CESAJ/SAJ02@CESAJ

From: Richard E Punnett/CESAJ/SAJ02@CESAJ
Date: 02/15/2001 03:14:00 PM
Subject: ENP ISOP Analysis

Col. May:

I have completed a review of the analysis conducted by ENP hydrologists concerning the efficacy of the ISOP operations. Many of the participants of the Quarterly Meeting (held 22-23 Jan 2001) were provided a copy of this email response. You may recall at the meeting that Dave Sikkima reported that the ENP had completed an analysis which concluded the ISOP did not meet the RPA requirements. He further stated that they would share that analysis with us after the meeting. I was surprised by his announcement of the analysis (and findings), but could not address their effort at that time. However, having reviewed their material, I can say that the effort falls well short of any professional conclusions. The analysis is attached in two powerpoint files.

The ENP analysis focused primarily on the eastern side of the ENP, on subpopulation E and F in particular. The ENP hydrologists contend that there was no beneficial impact from ISOP operations. In order to evaluate that statement further, I used the same time-frames and gages referenced in the ENP material, and compared the average gage stages at two sites: 4 mile northwest and 2 miles west (RG1 and RG2) of the seepage reservoir at S-332B. The periods of comparison were from 15 July to 30 September in both 1998 and 2000. The rainfall in 2000 was about 3.6 inches less than in 1998. Furthermore, the L-31N canal stages in 200 averaged about 0.2 ft lower than 1998 stages. Thus, with both lower canal stages and less rainfall, one would expect the year 2000 stages at the gages to be lower than the 1998 stages. However, just the opposite is true. In the year 2000, both gages averaged higher stages (by 0.24 and 0.26ft) than the 1998 stages. It should be noted that the S-332B seepage reservoir was in operation during the year 2000 season.

While I do not consider this kind of analysis to be proof of the efficacy of ISOP operations for the CSSS, I do contend that this more detailed analysis of ISOP shows a potentially favorable as well as significant effect. This is, of course, contrary to the conclusion the ENP hydrologists derived from a single hydrograph from each time period. It seems to me that the evaluation by the ENP hydrologists was little more than a non-professional rush to judgment in order to declare the ISOP a failure.

I believe there would be little to gain in a technical discussion between our two agencies on this matter. I do believe much could be gained by having the USGS review and evaluate the ENP analysis. The USGS is highly regarded by the Corps as an impartial, professional, and technically competent organization. I strongly recommend that we forward a copy of the attached material and ask the USGS to review the ENP analysis to see if the conclusions are merited.

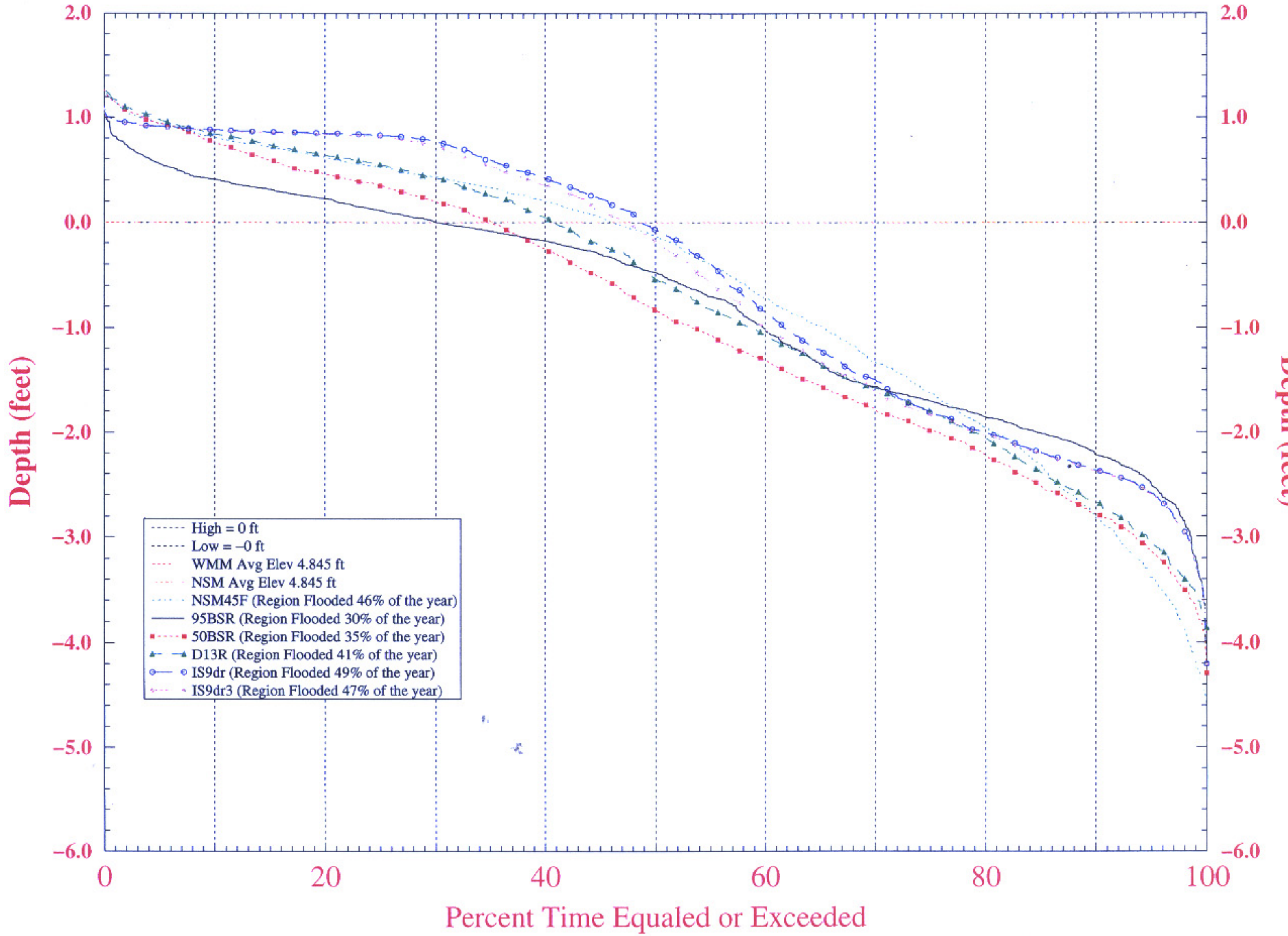
According to the Biological Opinion, the ISOP operations must equal or exceed the conditions that would occur if 30 percent of regulatory releases were made at Tamiami Trail and the Test 7 Phase II triggers were used during the year 2000. Only by modeling the 2000 hydrometeorological conditions can that condition be predicted. The ENP hydrologists made no such effort. Furthermore, the analysis is not possible until the SFWMD staff updates the modeling database later this spring. I expect to conduct all the necessary modeling studies needed clarify the issue of ISOP effectiveness as the data becomes available. I can provide my quick analysis (limited so far by preparation of the Draft EIS) to others as soon as I make it presentable. However, the analysis needs to be far more complete (with modeling) before defendable conclusions can be reached.

I hope that the USGS could be involved quickly in a review capacity on CSSS technical issues. The review of the ENP analysis is a good first-step opportunity. I further hope that they could stay involve to help solidify the federal positions on technical matters.

Richard

Fig. 1 Normalized Weekly Stage Duration Curves for Cape Sable Sparrow C

Indicator Region 55 (R10C23–23 R11C23–23)



Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicate ponding while values below zero indicate depth to the water table.

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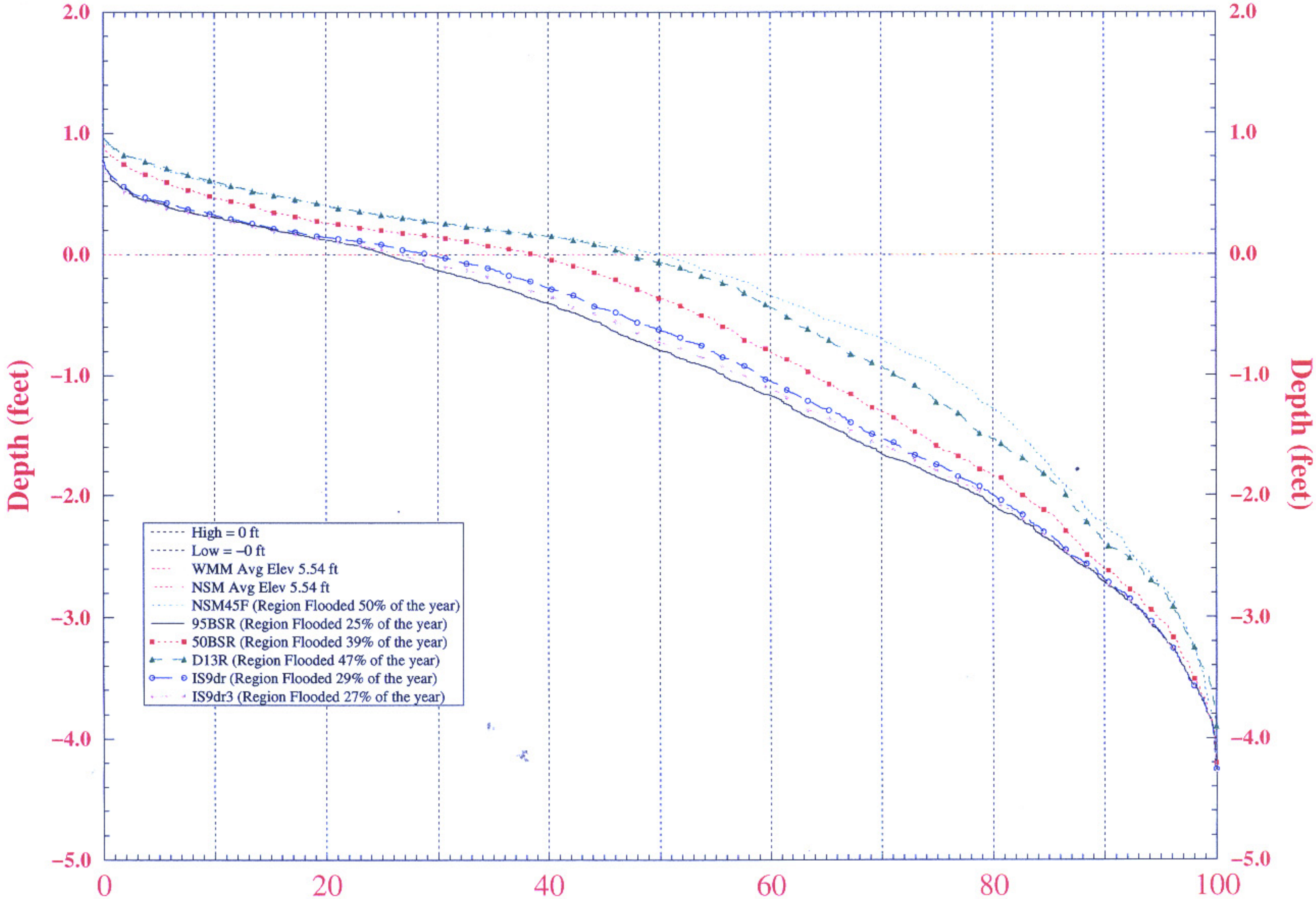
Fig. 2 Normalized Weekly Stage Duration Curves for Cape Sable Sparrow E

Indicator Region 57 (R12C21–21 R13C20–21 R14C20–21)



Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicate ponding while values below zero indicate depth to the water table.

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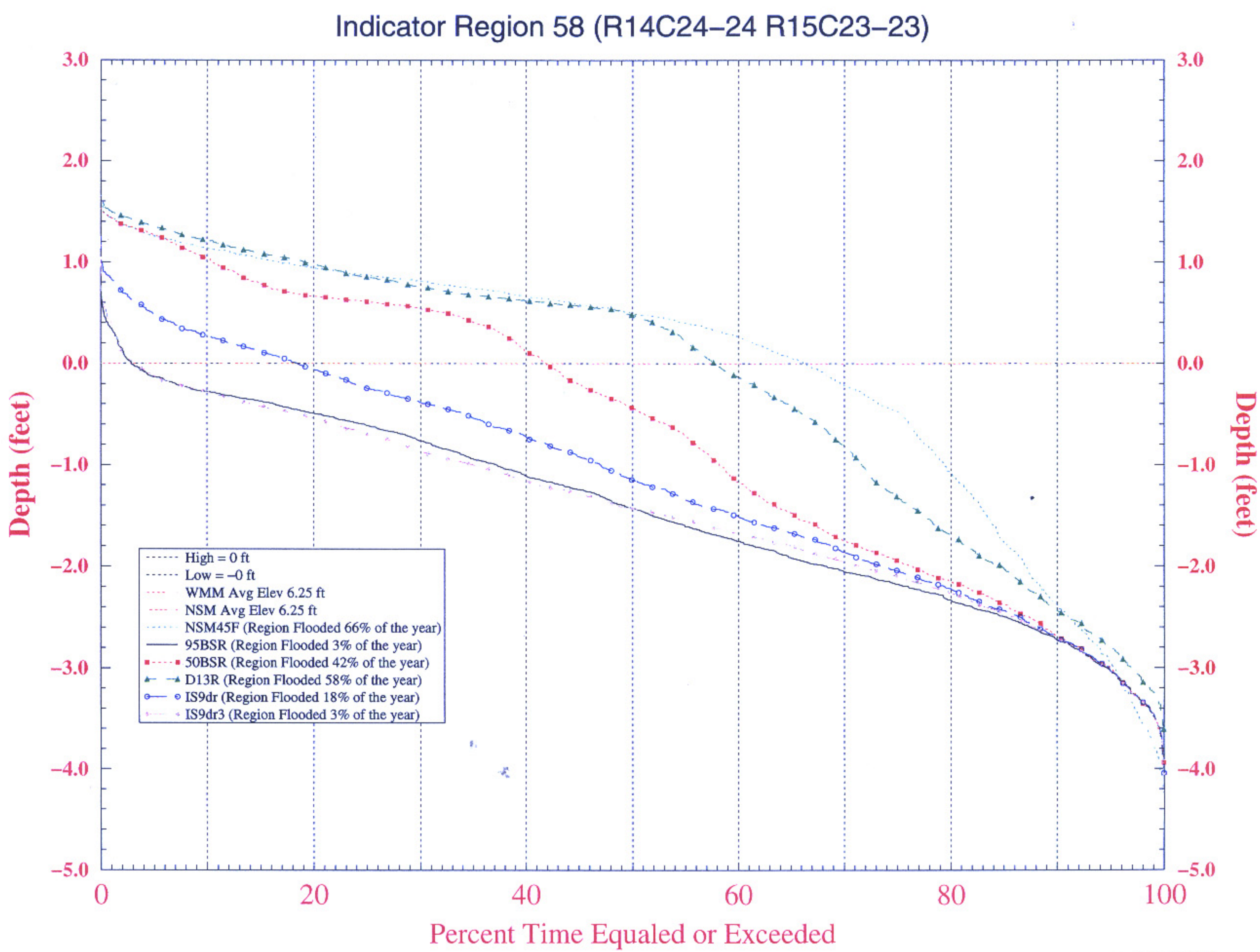
Fig. 3 Normalized Weekly Stage Duration Curves for Cape Sable Sparrow F



Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicate ponding while values below zero indicate depth to the water table.

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Appendix B.

MEMORANDUM
TO: Sherry Mitchell-Buker
FROM: Mike Zimmerman
DATE: April 19, 2001
RE: Analysis of CSSS Water Quality Data from 2000

I have done a preliminary analysis of the United States Army Corps of Engineer's (Corps) water quality data for the Cape Sable Seaside Sparrow Emergency Operations. About 4 months ago, I received a CD disk from Jim Riley (Corps) containing the "COE Sparrow Total Phosphorus Autosampler Data with Graphs (Aug. 1999 – Sep. 2000)." On March 21, 2001 I received an e-mail message with an attached zipped data file from Mr. Riley. The zipped data file contained an update on the Corps total phosphorus autosampler data.

The accuracy of these data has been questioned. FDEP reviewed the precision and accuracy problems with these data. FDEP found a positive bias of approximately 16-ppb for split samples taken prior to June 2000. The samples subsequent to June 2000 are qualified as estimates if the total phosphorus concentration is less than 16ppb because of the method detection limit and practical quantitation limit problems. However, these data are presently the best available data set from the C-111 Basin.

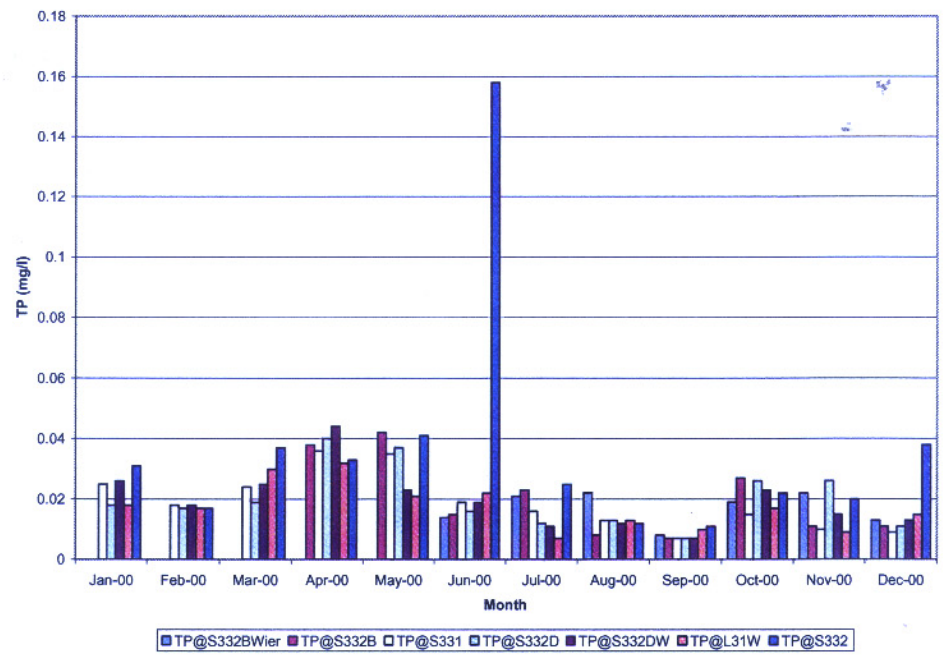

Figure 1 Monthly TP Concentrations at C-111 Sites

The high value for S332 in June and December exemplifies the problem with these data sets. There are 3 samples with TP concentrations over 2 mg/l in June. In the December data set there are two high values on December 31st. I am not sure if these high values are recording errors or real concentrations. I checked the latest data summary that I received in March and two of the June samples were not present. Further data verification (QA/QC) needs to be made of this earlier data.

Figures 2 thru 8 summarize the monthly mean TP concentrations for each individual station.

From these databases, I took the total phosphorus concentration for each discrete sample and averaged them into a daily arithmetic mean. Then, I computed a monthly arithmetic mean for each station from these daily means. Figure 1 shows the monthly means for all 7 autosampler stations for comparative purposes.

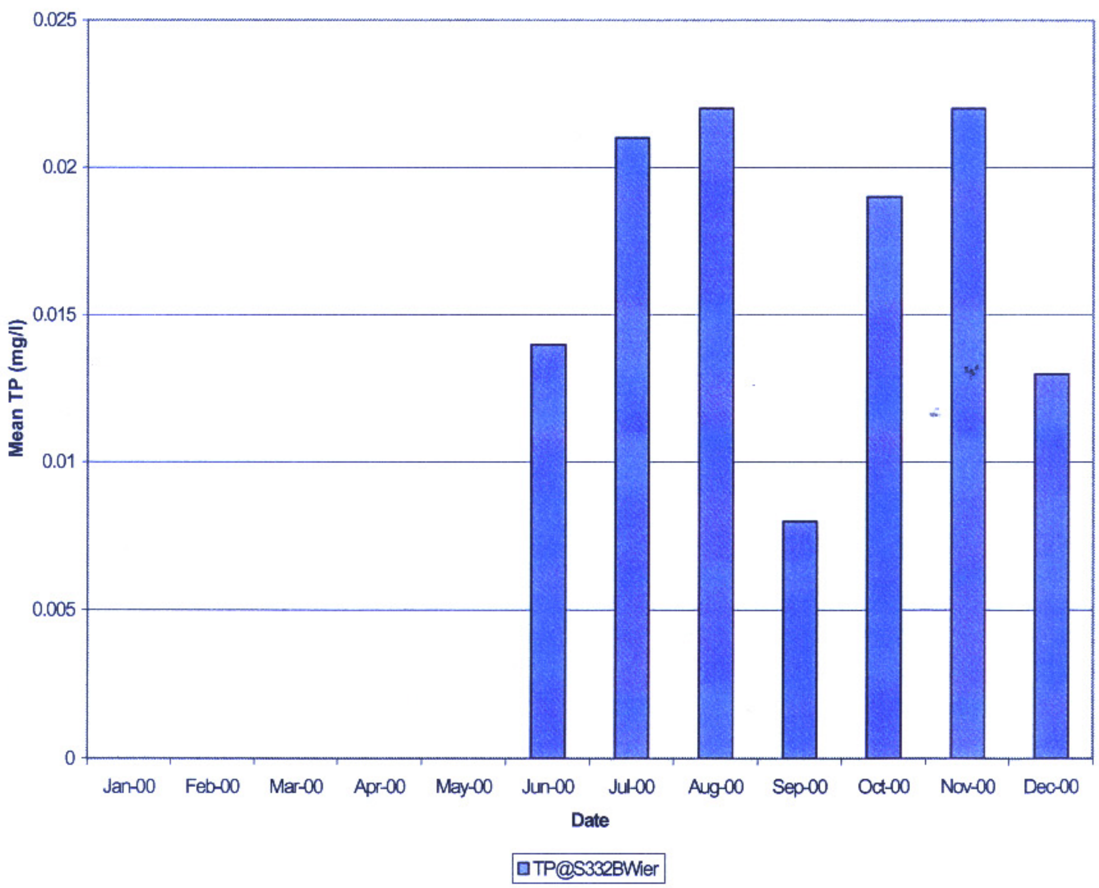

Figure 2 Monthly TP Concentrations @ S-332B Weir

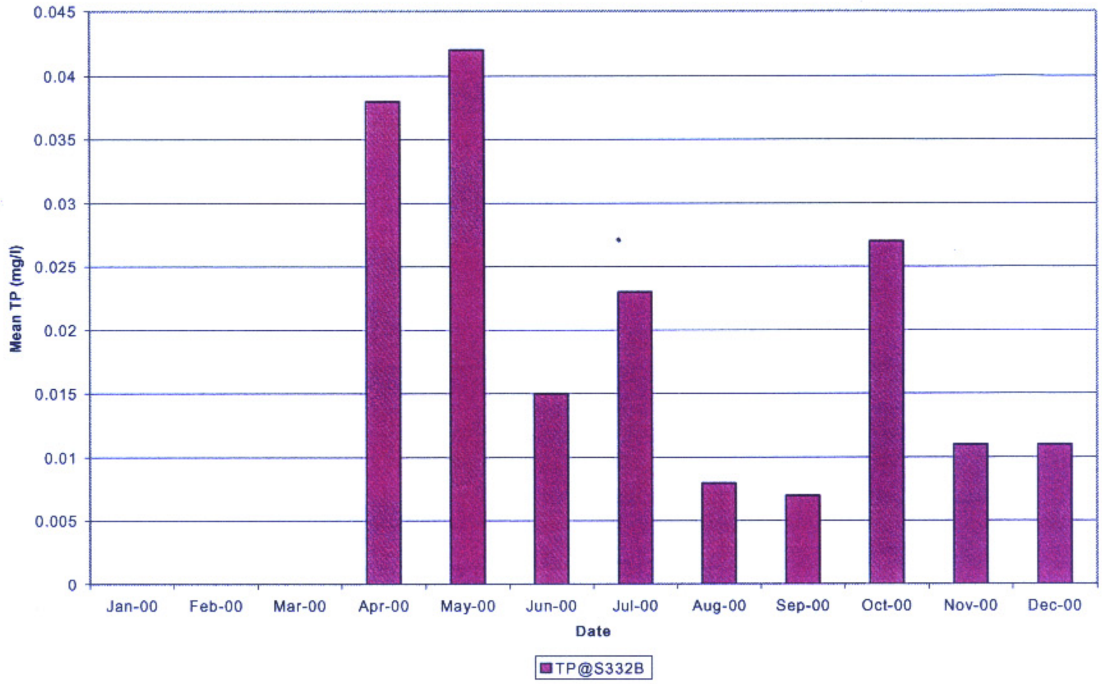

Figure 3 Monthly TP Concentrations @ S-332B

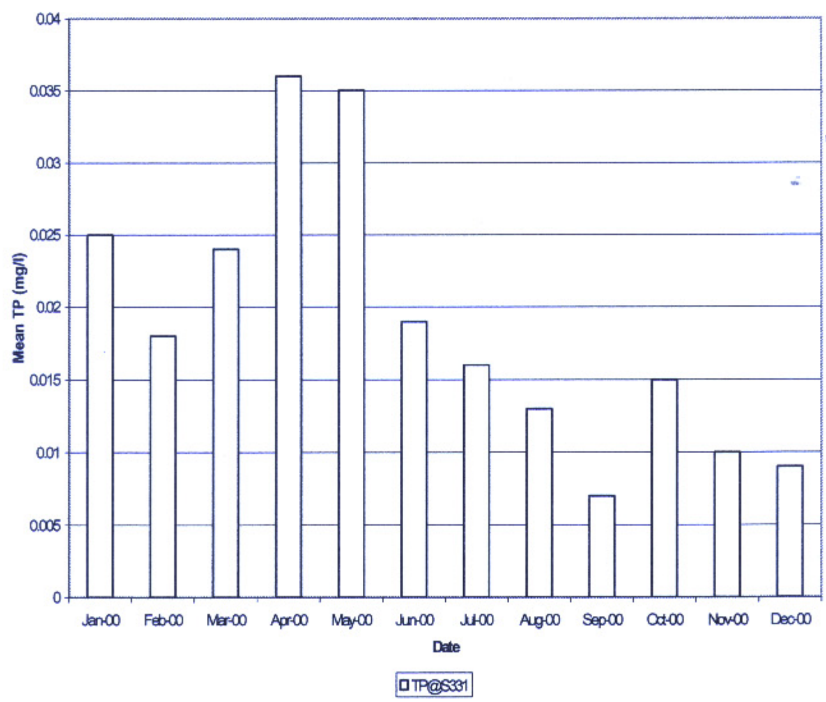

Figure 4 Monthly TP Concentrations @ S-331

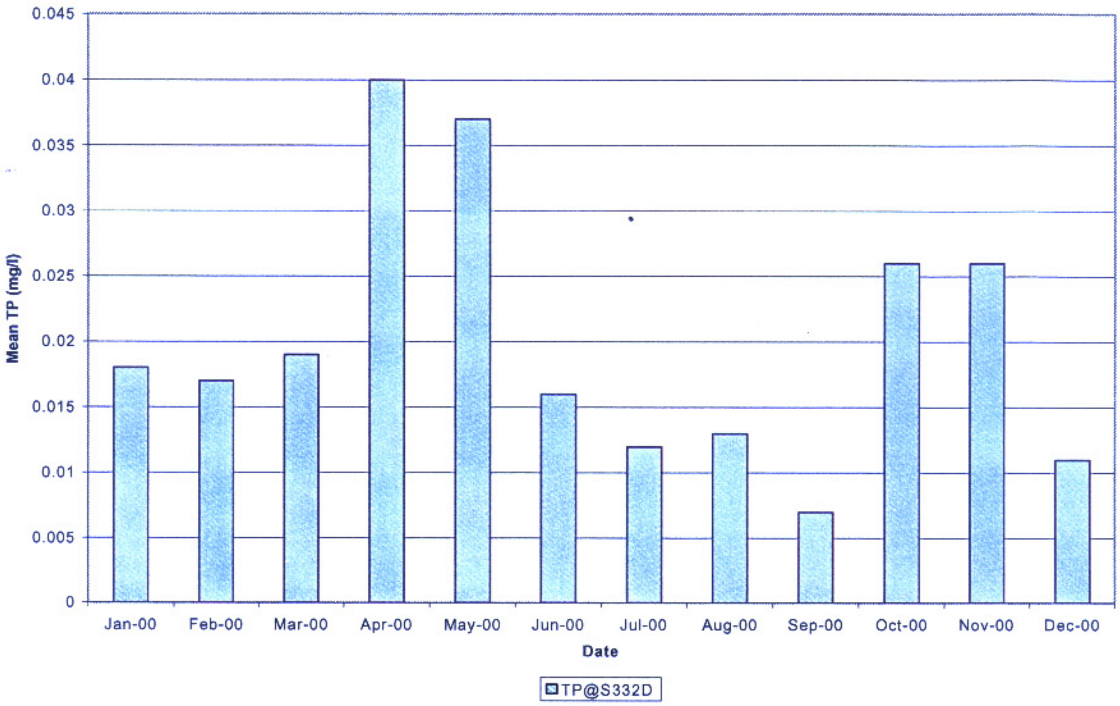

Figure 5 Monthly TP Concentrations @ S-332D Upstream

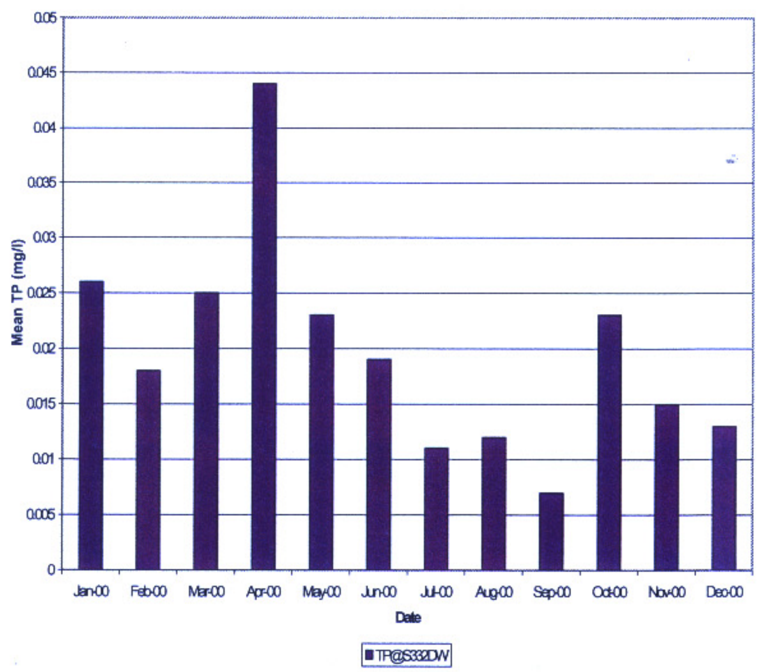

Figure 6 Monthly TP Concentrations @ S-332D Downstream

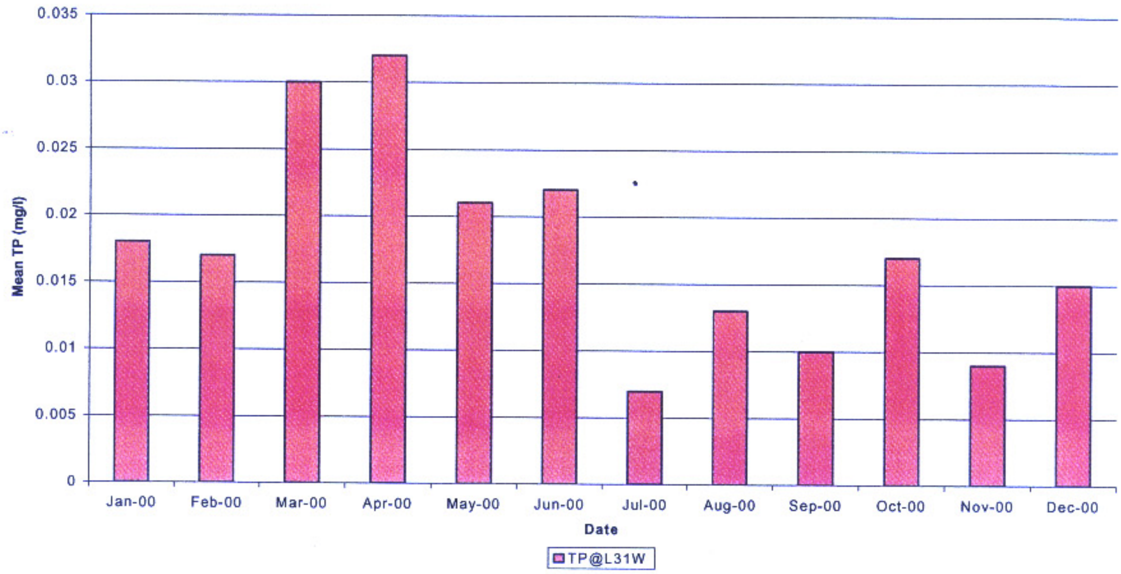

Figure 7 Monthly TP Concentrations @ L-31W

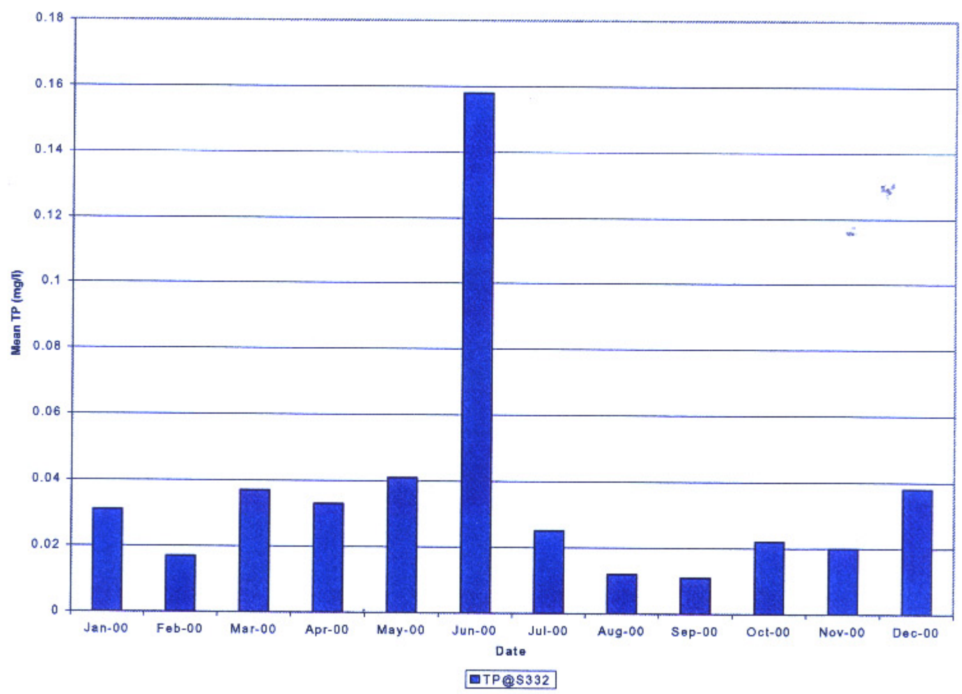

Figure 8 Monthly TP Concentrations @ S-332

Appendix C. Interim Operating Plan Performance Scores for Priority One and Two and Three Objectives.

AGGREGATE MEAN SCORES FOR ALL PERFORMANCE MEASURES					
	Mean and Aggragate Scores				
	Base Condition (Base 95)	Corps Preferred Alternative	Other Alternatives		
	Test 7 Phase 1	Alternative 5	Alternative 1	Alternative 6	RPA
PERFORMANCE MEASURES		Phase 1-IOP 2B*	ISOP 9dR	IOP 5a	RPA02
Priority 1 Objectives					
1A-Cape Sable Seaside Sparrow (Western Population)	1	5	5	5	5
1B-Cape Sable Seaside Sparrow (Eastern Populations)	1	1	1	1	5
Mean Aggregate	**2**	**6**	**6**	**6**	**10**
Normalized[1] Mean Aggregate	**23**	**69**	**69**	**69**	**115**
Priority 2 Objectives					
2A-Wood Stork	1	1	1	1	1
2B-Snail Kite	5	1	1	1	5
2C-West-Indian Manatee	4	1	2	1	3
2D-American Crocodile	3	2	3	2	2
Mean Aggregate	**13**	**6**	**7**	**6**	**11**
Normalized[1] Mean Aggregate	**75**	**32**	**37**	**32**	**60**

Appendix C. cont...,. Interim Operating Plan Performance Scores for Priority One and Two and Three Objectives.

AGGREGATE MEAN SCORES FOR ALL PERFORMANCE MEASURES					
	Mean and Aggragate Scores				
	Base Condition (Base 95)	Corps Preferred Alternative	Other Alternatives		
	Test 7 Phase 1	Alternative 5	Alternative 1	Alternative 6	RPA
PERFORMANCE MEASURES		Phase 1-IOP 2B*	ISOP 9dR	IOP 5a	RPA02
3A-Tree Islands (WCA3A)	5	4	4	4	1
3B-Slough Vegetation (WCA3A)	3	1	1	1	3
3C-Water Quality (WCA3A)	4	1	1	1	5
3D-Wading Bird Foraging Habitat (WCA3A)	1	1	1	1	1
3E-Aquatic Communities (WCA3A)	1	1	1	1	1
3F-Tree Islands (WCA3B)	1	1	1	1	1
3G-Slough Vegetation (WCA3B)	5	1	1	1	5
3H-Water Quality (WCA3B)	5	1	1	1	5
3I-Wading Bird Foraging Habitat (WCA3B)	1	1	1	1	1
3J-Aquatic Communities (WCA3B)	4	1	1	1	3
3K-Tree Islands (NESS)	1	1	1	1	1
3L-Slough Vegetation (NESS)	3	1	1	1	3
3M-Water Quality (NESS)	5	1	3	3	4
3N-Wading Bird Foraging Habitat (NESS)	1	1	1	1	1
3O-Aquatic Communities (NESS)	3	1	1	1	4
3P-Water Quality (Rocky Glades)	5	2	1	3	4
3Q-Tree Islands (SSS)	1	1	1	1	1
3R-Slough Vegetation (SSS)	4	1	1	1	5
3S-Water Quality (SSS)	5	1	3	3	4
3T-Wading Bird Foraging Habitat (SSS)	1	1	1	1	1
3U-Aquatic Communities (SSS)	5	1	1	1	2
3V-Shark Slough Estuaries	3	1	1	1	3
3W-Florida Bay	1	5	5	5	5
Mean Aggregate	**67**	**31**	**34**	**36**	**64**
Normalized[1] Mean Aggregate	**67**	**31**	**34**	**36**	**64**

[1] Normalized for Difference in Number of Performance Measures for Each Project Objective: Objective 1 (12), Objective 2 (5.75), and Objective 3 (1)

Addendum- Preliminary Analysis of Alternative 7

A.1 Introduction and Background

As documented in the body of this CAR, monitoring of actual implementation of the ISOP revealed that some aspects of the ISOP did not function in the way the Corps expected them to based on their SFWMM modeling and other design analyses, and revealed some additional adverse biological impacts to CSSS habitat and other areas that were not anticipated. Additionally, actual implementation of the ISOP included some significant changes in operations that were not included in the SFWMM modeling at all. These results of actual monitoring led the FWS and NPS to conclude that the ISOP, and other similar operations proposed as IOP Alternatives 1, 5 and 6 and under various other names, were unlikely to meet ESA requirements for the CSSS and were likely to cause significant additional adverse impacts to other natural areas. The Corps initial development of IOP alternatives, as presented in the draft IOP EIS, did not take all of these lessons learned from actual implementation into account. Accordingly, FWS and NPS expressed their concern and suggested to the Corps that IOP development should be viewed as an opportunity to acknowledge and correct the significant limitations of the SFWMM and unintended consequences of actual ISOP implementation.

Several months after release of the draft IOP EIS, the Corps agreed to work with FWS, NPS and SFWMD to include lessons learned from the ISOP into an adjusted IOP alternative. These discussions were successful, and FWS and NPS are pleased to express our support for the resulting Alternative 7. However, development of this adjusted alternative was completed just a few working days before the second draft IOP EIS needed to be completed, leaving insufficient time for a full analysis of Alternative 7 in this CAR. Therefore, this greatly abbreviated preliminary analysis has been included as an addendum. Our analysis is presented as a discussion of how Alternative 7 successfully addresses each of our recommendations for improvement of the draft IOP EIS alternatives (see Summary and Conclusions section). **Table A.1** provides the precise operational rules for Alternative 7 normal operations. Flood control emergency operations for Alternative 7 are provided in the attached *Pre-Storm / Storm / and Storm Recovery Operations for the South Dade Conveyance System* document.

A.2 Response to Recommendations for improvement of IOP Alternatives

A.2.1 Recommendation:

"Although FWS and NPS fully support building the second S-332B retention area and believe that this feature will reduce expected adverse effects, canal stage criteria must also be significantly adjusted from those presented in Alt6P1 in order to eliminate additional adverse effects resulting from flooding of some CSSS habitat areas and over-drainage of others".

Alt7 Response: Alternative 7 includes the second S-332B retention area and addresses additional adverse effects resulting from flooding of some areas in several ways: 1) canal stage criteria are increased as compared to the other alternatives, reducing the volume of water pumped into ENP and CSSS habitats at point sources; 2) operations of S-332B will not be allowed to

Table A.1. IOP Alternative 7 Operations

	No WCA-3A Regulatory Releases to SDCS or Shark Slough	WCA-3A Regulatory Releases to SDCS
Regulation Schedule	Deviation schedule for WCA-3A as specified by USACE including raising Zone D to Zone C from Nov 1 to Feb 11. No deviation in WCA-2A regulation schedule.	Deviation schedule for WCA-3A as specified by USACE including raising Zone D to Zone C from Nov 1 to Feb 11. No deviation in WCA-2A regulation schedule.
S-343 A/B and S-344	Closed Nov 1 to July 15 independent of WCA-3A levels.	Closed Nov 1 to July 15 independent of WCA-3A levels.
S-12 A/B/C/D	S-12A closed Nov 1 to Jul 15; S-12B closed Jan 1 to Jul 15; S-12C closed Feb 1 to Jul 15; S-12D no closure dates. Follow WCA 3A regulation schedule after Jul 15. Note: If closure requires regulatory releases to SDCS then switch to operations for regulatory releases to SDCS.	S-12A closed Nov 1 to Jul 15; S-12B closed Jan 1 to Jul 15; S-12C closed Feb 1 to Jul 15; S-12D no closure dates. Follow WCA 3A regulation schedule after Jul 15.
S-333: G-3273 < 6.8' NGVD Degrade the lower four miles of the L-67 extension	55% of the rainfall plan target to NESRS and 45% through the S-12 structures	55% of the rainfall plan target to NESRS, plus as much of the remaining 45% that the S-12s can't discharge to be passed through S-334; and subject to capacity constraints, which are 1350 cfs at S-333, L-29 maximum stage limit, and canal stage limits downstream of S-334.
S-333: G-3273 > 6.8' NGVD	Closed	Match S-333 with S-334 flows
L-29 constraint	9.0 ft	9.0 ft
S-355A&B	Follow the same constraints as S-333. Open whenever gradient allows southerly flow.	Follow the same constraints as S-333. Open whenever gradient allows southerly flow.
S-337	Water Supply	Regulatory releases as per WCA-3A deviation schedule.
S-151	Water Supply	Regulatory releases as per WCA-3A deviation schedule.
S-335	Water Supply Allow releases through S-335 if there is downstream capacity consistent with pre-ISOP operations. "Downstream capacity" would not include capacity created by pumping at S-332B or S-332D and not trigger opening S-18C at 2.6. Note: It is recognized that under these conditions operations of S-335 would be infrequent.	When making regulatory releases through S-151, match S-335 outflows with inflows from S-151 and S-337

Table A.1 cont. IOP Alternative 7 Operations

	No WCA-3A Regulatory Releases to SDCS or Shark Slough	WCA-3A Regulatory Releases to SDCS
S-334	Closed	Pass all or partial S-333 flows Depending on stage at G-3273 (see note 3)
S-338	Open 5.8 Close 5.5	Open 5.8 Close 5.4
G-211	Open 6.0 Close 5.5	Open 5.7 Close 5.3
S-331	Angel's Criteria	Angel's Criteria
S-332B Note 1: There will be two 125-cfs pumps and one 75-cfs pump directed to the second detention basin. The remaining two 125-cfs pumps will be directed to the first detention basin. If possible, the 75-cfs pump will be designed so that it can be directed to either basin. Note 2: A new indicator will be established for Subpopulation F and a new gauge will be installed about ½ mile west of the weir on the western edge of the retention area. Pumping will cease after 180 days of above ground hydroperiod at the new gauge during a year that runs from July 15th to July 14th. After water levels recede below ground, pumping can be resumed at a rate that maintains water elevations below ground at the gauge until the beginning of the next year.	Pumped up to 250 cfs* from Jun through Feb; and 125 cfs from Mar through May. On 5.0 Off 4.7** *This pumping rate is based on the assumption that there will be no overflow into the Park. If there is overflow into the Park, the pumping rate will be adjusted. **If, after the first 30 days of operation, there is no observed drawdown at the pump, this stage level will be raised to 4.8	Pumped up to 250 cfs* from Jun through Feb; and 125 cfs from Mar through May. On 4.8 Off 4.5 *This pumping rate is based on the assumption that there will be no overflow into the Park. If there is overflow into the Park, the pumping rate will be adjusted to eliminate overflow.
S-332B Seepage Reservoir	400 acres with no overflow to the west	400 acres with with no overflow to the west
S-332D	Pumped up to 500 cfs from Jul 16 (or the end of the breeding season, as confirmed by FWS) to Nov 31; 325 cfs from Dec 1 to Jan 31; and 165 cfs* from Feb 1 to Jul 15. Meet Taylor Slough Rainfall formula (No L-31W constraint) On 4.85 Off 4.65 *New information will be sought to evaluate the feasibility of modifying the 165 cfs constraint	Pumped up to 500 cfs from Jul 16 (or the end of the breeding season, as confirmed by FWS) to Nov 31; 325 cfs from Dec 1 to Jan 31; and 165 cfs* from Feb 1 to Jul 15. Meet Taylor Slough Rainfall formula (No L-31W constraint) On 4.7 Off 4.5 *New information will be sought to evaluate the feasibility of modifying the 165 cfs constraint

Table A.1 cont. IOP Alternative 7 Operations

	No WCA-3A Regulatory Releases to SDCS or Shark Slough	**WCA-3A Regulatory Releases to SDCS**
S-332	Closed	Closed
S-175	Closed	Closed
S-194	Open 5.5 Close 4.8	Operated to maximize flood control discharges to coast Open 4.9 Close 4.5
S-196	Open 5.5 Close 4.8	Operated to maximize flood control discharges to coast Open 4.9 Close 4.5
S-176	Open 5.0 Close 4.75	Open 4.9 Close 4.7
S-177	Open 4.2 (see S-197 open) Close 3.6	Open 4.2 (see S-197 open) Close 3.6
S-18C	Open 2.6 Close 2.3	Open 2.25 Close 2.00
S-197		

S-197 open and criteria remains consistent with Test 7 Phase I criteria for S-177
Use S-333/334 before S-335

cause overflow of the S-332B retention area(s) into CSSS habitat except in precisely-defined emergency situations; 3) SDCS operations will not be allowed to provide additional capacity for S-335 flood control operations in excess of capacity provided during Test 7 Phase I implementation; and, 4) a trigger will prevent further S-332B operations if the adjacent CSSS habitat experiences hydroperiods greater than 180 days. Overdrainage of areas adjacent to the SDCS canals is addressed through restoring canal stage criteria to Test 7 Phase I levels or higher when regulatory releases from WCA-3A are not being brought around to the SDCS. Hydroperiods in the CSSS habitats adjacent to the SDCS will be increased beyond Test 7 Phase I hydroperiods by carefully controlled pumping into these habitats when WCA-3A water is being brought around. Canal level criteria during periods when WCA-3A water is brought around are only slightly lower than Test 7 Phase I levels, reducing seepage losses that would otherwise result in a net reduction in hydroperiods in some areas. Hydroperiods in CSSS sub-population E will be enhanced through degradation of the lower portion of the L-67E levee, which should allow more S-12D flows to move towards this habitat area. Additionally, the L-67E change should increase the getaway capacity for S-12D, potentially improving the IOPs ability to alleviate high water situations in WCA-3A and potentially enhancing water flows and volumes in Shark Slough and the Shark Slough estuaries.

A.2.2 Recommendation:

"The "Pre-storm drawdown" operations for non-tropical events should not be included in the final selected plan".

Alt7 Response: Alternative 7 does not include pre-storm drawdown operations for non-tropical events, and operations for tropical events have been precisely defined to include operations that have potential adverse effects on CSSS habitats only during emergencies.

A.2.3 Recommendation:

"S-334 should be the primary mode of routing WCA-3A regulatory flows to the SDCS. S-335 should only be operated to route excess flows from WCA-3A via S-337, or when needed for water supply during the dry season. S-332B and S-332D should only provide downstream capacity for S-335 flows that is equal to the flow from S-337. The capacity of S-333 should be extended beyond 1350 cfs by providing for additional reinforcement downstream of the structure".

Alt7 Response: In Alternative 7, S-334 will be the primary route for WCA-3A regulatory flows to the SDCS, with S-335 used as a secondary route for these flows. When WCA-3A flows are not being routed to the SDCS, S-335 will only be opened for water supply or when there is downstream capacity as it was defined during Test 7 Phase I implementation. As part of Alternative 7, the Corps will request authorization to provide for additional reinforcement downstream of S-333. Releases beyond 1350 cfs would occur if and when it can be demonstrated that such releases would not adversely impact private property.

A.2.4 Recommendation:

"S-332B detention area should not be allowed to overflow except under very limited emergency circumstances".

Alt7 Response: In Alternative 7, the S-332B retention area(s) will only be allowed to overflow into ENP and CSSS habitat under limited emergency circumstances as defined in the attached *Pre-Storm / Storm / and Storm Recovery Operations for the South Dade Conveyance System* document. Otherwise, S-332B pumping will be reduced or stopped to avoid overflow into the CSSS habitat.

A.2.5 Recommendation:

"Improvements in the SFWMM and the MODBRANCH model should be expedited for the Combined Structural and Operational Plan effort to better represent alternatives that include effects due to local sources and small retention areas, such as S-332B. Results of hydrologic monitoring and analysis presented in Chapter 4 should be considered in development of additional IOP alternatives".

Alt7 Response: Several aspects of Alternative 7 were designed using results of monitoring of actual ISOP operations analyzed in Chapter 4. The Corps has agreed to used improved SFWMM and MODBRANCH modeling for the CSOP.

A.2.6 Recommendation:

"Operations for the IOP should be detailed in an Operations and Maintenance Manual. Agreement should be reached between DOI, Corps and SFWMD that this manual reflects the operations as specified in the final EIS. The manual should include provisions for monitoring and emergency operations, as well as mechanisms for dispute resolution, modifications as a result of new information to assure compliance in a manner satisfactory to all agencies".

Alt7 Response: The Corps has agreed to use a collaborative approach to reach consensus with NPS, FWS and SFWMD on IOP operations.

A.2.7 Recommendation:

"Mitigative measures for regulatory releases into the SDCS, such as lowering canal stages and increased pumping, should be taken only while making regulatory releases".

Alt7 Response: In Alternative 7, lowered canal stages and increased pumping will only be implemented when WCA-3A regulatory releases are being brought around to the SDCS, except under limited emergency circumstances defined in the *Pre-Storm / Storm / and Storm Recovery Operations for the South Dade Conveyance System* document.

A.2.8 Recommendation:

"S-332B operation should be regulated by water levels in the sub-population F habitat to preclude adverse effects to the CSSS habitat".

Alt7 Response: Alternative 7 includes a trigger that will prevent further S-332B operations if the adjacent CSSS habitat experiences hydroperiods greater than 180 days.

A.2.9 Recommendation:

"S-355A and S-355B should be operated to avoid adverse impacts to WCA-3B and NESS. S-355A and S-355B should not be open when water levels in the headwater are less than the tail-water water levels".

Alt7 Response: Alternative 7 includes S-355A and B operations that will open these structures only when water levels in the headwater are less than the tail-water water levels".

A.3 Threatened and Endangered Species

A.3.1 Cape Sable seaside sparrow.

As explained above, Alternative 7 includes features that address each of the concerns that led FWS to conclude that the ISOP and draft IOP EIS alternatives would not likely meet ESA requirements for the sparrow. RPA hydroperiod and nesting habitat availability requirements for sub-population A are provided to the maximum extent possible via previously agreed operations of the S-12s and related structures, as documented in Chapter 5. For sub-populations C and D, Alternative 7 operations should provide biological conditions necessary to avoid jeopardizing the CSSS' continued existence since the S-335 operations that likely delivered too much water to sub-population D have been eliminated. For sub-population F and other natural areas adjacent to L-31N that need to be managed to reduce fire risk for CSSS habitats, Alternative 7's increased canal stages, additional S-332B retention area, and limits on S-332B pumping and overflow should provide biological conditions in these areas equivalent to those expected under the RPA. For sub-population E, degradation of the lower portion of the L-67E levee, combined with reduced seepage losses that should result from Alternative 7's higher canal stages, should provide biological conditions in this area equivalent to those expected under the RPA.

For the sub-population E and F habitats, the SFWMM results for Alternative 7 may not show a match to the RPA02 model run. This is to be expected and is not a concern for FWS because we know that the SFWMM model does not provide an accurate representation of S-332B operations. Instead of relying on the inaccurate SFWMM model results to design S-332B operations, the Corps, SFWMD, NPS and FWS relied on actual monitoring data, experience with actual operation of the SDCS and our combined best professional judgement to design S-332B operations for Alternative 7.

A.3.2 Other listed species

For the wood stork, snail kite, West-Indian manatee and American crocodile, Alternative 7 should maintain or improve habitat suitability as compared to the ISOP and draft IOP EIS alternatives. Elimination of the S-335 drainage effects on WCA-3B, and increased getaway capacity at S-12D created by the L-67E modifications may even provide for some improvement in wood stork and snail kite habitats in WCA-3 and Shark Slough and manatee and crocodile habitats in the Shark Slough estuaries. Any adverse effects to these species should fall within the sideboards of the February 19, 1999, biological opinion and are therefore covered by that document. Construction of the second S-332B retention area could cause some adverse effects to the eastern indigo snake. However, the Corps will implement standard indigo snake protection construction protocols consistent with the February 19, 1999, biological opinion, so no additional adverse effects are anticipated. Construction of the second S-332B retention area may also affect the Florida panther since this area has received occasional panther use. Any adverse effects associated with this will be handled through additional ESA consultation, to be completed prior to a Record of Decision on the IOP.

A.4 Environmentally Preferred Alternative

FWS and NPS continue to recommend the RPA as the environmentally preferred alternative because it continues to provide the most balanced and overall ecological benefits. However, Alternative 7 is an acceptable alternative to the RPA because the best currently available scientific information indicates that it will likely meet ESA requirements for the CSSS.

A.5 Summary and Conclusions

The best currently available scientific and commercial information indicates that the ISOP and first draft IOP EIS alternatives are not likely to comply with ESA requirements. However, the best currently available scientific and commercial information indicates Alternative 7 is likely to comply with ESA requirements, and minimize adverse effects to natural resources as compared to the ISOP and first draft IOP EIS Alternatives. Although the FWS and NPS continue to recommend the RPA as the environmentally preferred alternative for the IOP, we find Alternative 7 acceptable and greatly appreciate the Corps and SFWMD's willingness to work out this agreement with us.

Attachment A.1-Pre-Storm / Storm / and Storm Recovery Operations for the South Dade Conveyance System

This document provides criteria to be used in preparing the South Dade Conveyance System (SDCS)/Miami Dade County for forecasted storm events. The SDCS is composed of L-31N, L-31W, and C-111 canal system and control structures. Currently, for the East Coast Canal System, the canal system and control structures to the east of L-31N, the South Florida Water Management District (SFWMD) implements canal drawdown operations based on impending rainfall events. The goal for the SDCS is to develop a similar set of canal drawdown operating criteria which seek to balance the needs of the natural system with the authorized purposes of the Central and Southern Florida (C&SF) Project, which is multipurpose in scope and includes flood control and water supply.

The hurricane season is from June through November. When there are tropical depressions, tropical storms, and/or hurricanes in the Atlantic/Caribbean Basin, the National Hurricane Center (NHC) issue tropical cyclone public advisories, forecast advisories, forecast discussions, and strike probability forecasts* every 6 hours.

The SFWMD employs meteorologists who evaluate each tropical event and prepare average forecast errors using NHC forecast tracking maps. The average forecast error means when the Hydrometeorologic Prediction Center (HPC) or NHC has forecasted a specific track and the cyclone could end up anywhere in that "swath" within the next 72 hours with around a 60% confidence level. The average forecast error swath is based on the 10-year average of forecast errors.

The SFWMD Operations Control Division has defined operational procedures to be implemented depending on the timing or amount of advance warning prior to the onset of tropical storm force winds. The Corps of Engineers also has defined in the Master Water Control Manual for each part of the Central and Southern Florida Project (C&SF) a water control plan with instructions for pre-storm operations for structures around Lake Okeechobee and the Water Conservation Areas. The SFWMD operational procedures are termed "Conditions", the specific operating procedures for these conditions will be described in further detail in this document. Conditions are briefly summarized as follows:

- Condition 4, 72 – 48 hours prior to the impact of tropical storm force winds, is earliest level of preparation when the system is evaluated and initial adjustments made to operations depending on the forecast and nature of the storm. Coordinate with the Corps of Engineers and local drainage districts
- Condition 3, 48 – 24 hours prior to the impact of tropical storm force winds, continue pre-

[1] {For the period 1989-1998, the average location error by forecast period was 55 statute miles at 12 hours, 102 miles at 24 hours, 147 miles at 36 hours, 164 miles at 48 hours and 278 miles at 72 hours. The strike probability forecast indicate the statistical chance that the tropical cyclone center will pass within 75 statue miles of a specified location within 3 days of the initial forecast time. The maximum strike forecast probabilities are 10-15% at 72 hours, 20-25% at 48 hours, 25-35% at 36 hours, 40-50% at 24 hours, an 75-85% at 12 hours.}

storm operations and coordination with the Corps of Engineers and local drainage districts.

- Condition 2, 24 – 12 hours prior to the impact of tropical storm force winds, bring telemetry-controlled sites to final pre-storm configuration, establish alternate emergency control station if necessary.

The remaining levels of preparation are Condition 1, 12 – 0 hours prior to the impact of tropical storm force winds; During the event; and Recovery after the event. It is important to note that some storm events do not allow for the full condition 4 with even 48 hours of advance warning.

It is important to emphasize that the Central and Southern Florida Project is multi-purpose in design, and that pre-storm operations may not prevent flooding, such as experienced after Hurricane Irene in October 1999 or the no name storm in October 2000. The condition of the groundwater system at the time of a storm event is significant and is highly dependent on the amount and extent of rainfall that has already occurred prior to subsequent events. Further, there are areas of Dade County, and South Florida in general, which are at low elevations and for which no amount of drawdown can prevent flooding depending on the amount and extent of the event. The water levels discussed in this document are target levels and may not be attainable.

During the Cape Sable seaside sparrow nesting season, March 1 through July 15, or until nesting success, as defined in the Fish and Wildlife Service February 19, 1999 Final Biological Opinion, has been met, pumping at S-332D and S-332 is limited to 165 cfs. This constraint on pumping may limit the ability to implement pre-storm operations. At this time, the USACE Hydrologic Investigation Section is preparing modeling to determine possible impacts to sparrow nesting or implementing pre-storm operations.

Notification and Briefing Process

The Executive level will be briefed prior to initiation of pre-storm operations. This may occur prior to 72 hours or as soon as the average error forecast swath shows South Florida to be likely to be in the path of a storm. Obtaining Executive level approval is important in order to demonstrate to interested parties, such as the Fish and Wildlife Service and the National Park Service, that operations were not arbitrary or capricious and that possible impacts to the sparrow or to the natural system were considered; however, in order to maintain the multi-purpose functioning of the C&SF project, flood control operations were necessary.

1. Conditions 4 and 3 (24 to 72 Hours Prior to Storm Conditions)

Based on the Executive level orders, up to 72 hours in advance of a storm.

Drawdown Implementation:

Between 24 and 72 hours before tropical storm conditions in Miami-Dade, the following target water levels are set for the SDCS. The initiation of the pre-storm drawdown criteria would be triggered when Dade County is within the average error forecast swath as developed by the

NHC. These pre-storm drawdown levels are not less than the level at which water supply deliveries are made during dry periods, that is 1.5 ft below optimum canal levels, except the reach north of G-211, which is 1.0 ft below current, normal operating levels. These levels are target levels and may not be attainable.

Table 1.

Canal	Reach	Target Level for Draw-Down (ft)
L-31N	G-211 to S-331	4.0*
L-31N	S-331 to S-176	4.0
L-31W	S-174 to S-175	No target
C-111	S-176 to S-177	3.0
C-111	S-177 to S-18C	2.0
C-111	S-18C to S-197	No change**

* If Angel's well is 5.5 ft-NGVD or below, then 4.0 would be the target, otherwise, 3.5 ft-NGVD at the headwater of S-331 will be the target.
** Operation as specified in the SFWMD structure book for S-197

Sequence for Achieving Target Levels

In an effort to achieve the specified drawdown targets, a sequence of operational actions is recommended as described in Table 2. The goal is achieve one target before proceeding the next sequence, however, it may not be possible to achieve the target level and operations will proceed as based on the best available information at the time:

Table 2.

Sequence	Canal	Reach	Target Draw-Down Level (ft)
1	L-31N	S-331 to S-176	4.0
	C-111	S-176 to S-177	3.0
2	L-31N	G-211 to S-331	4.0*
	L-31N	S-335 to G-211	5.0

* If Angel's well is 5.5 ft-NGVD or below, then 4.0 would be the target, otherwise, 3.5 ft-NGVD at the headwater of S-331 will be the target.

S-332B

Operational criteria are being developed to meet the RPA requirements. The criteria will take into account pre-storm and storm operations, except emergency deviations that must always be dealt with on a case-by-case basis. S-332B is a part of the Central and Southern Florida (C&SF) Project, which is multipurpose in scope. While S-332B allows flexibility to operate the C&SF project to better meet the needs of the Cape Sable seaside sparrow it may also be used for meeting other project purposes such as flood control.

Table 3.

Rising Water Level (ft)	Discharge (cfs)	Falling Water Level (ft)	Rated Discharge (cfs)
4.7	75*	5.0	450
4.9	200**	4.9	325
5.0	325	4.8	200**
5.1	450	4.7	75*
5.2	575	4.2	0

* Start with 125-cfs pump if 75-cfs pump is not operational
** This will cause overflow of the weir in the retention area

During pre-storm operations, the criteria for operation of S-332B would be the same as under normal operations, however, the notification procedure is to take place prior to changes in the upstream or downstream structural operations. Refer to the notification and briefing process section of this document regarding briefing the Executive level prior to initiating pre-storm operations.

S-197

No change is suggested in the operational criteria for this structure during Condition 4. The operational criteria is defined the SFWMD structure book for S-197.

Table 4.

Structure	Status
S-331	Secure. Do not operate during storm.
S-332B	Secure. Personnel move to S-332D office area during storm.
S-332D	Continue pumping. Office area is hardened.
S-175	Keep closed
S-197	Consideration to be given to open 3 gates

2. Condition 2 and 1 (12 to 24 Hours Prior to Forecast arrival of tropical storm force winds).

Continue operations as in Condition 4 and 3, but with the following considerations:

S-332B

Pumps are secured for safety reasons. Personnel should move to S-332D for protection from tropical storm force winds, and to await resumption of operations at S-332B.

S-197

Operation of this structure requires mobilization of field personnel and equipment to operate the gates. It is not safe to operate this structure during storm conditions. Consequently, depending on conditions, three gates may be opened at Condition 1.

3. Recovery (Conditions immediately after the storm ends or if the storm forecast changes such that Dade County is no longer likely to be affected.)

Operations during Recovery consist of: 1) Maximizing discharges at water control structures to minimize flooding and 2) make the transition back to operational regime in place prior to the storm.

Operations may also be returned to levels prior to implementing pre-storm operations as soon as the Dade County is no longer within the average forecast error swath.

Plan for Worst Case: Recovery would be necessary if storm conditions result in significant rainfall in the Miami-Dade County area. The target for operations would be to return to operational regime in place prior to the storm. However, use of water control structures (e.g., S-175, S-332B) under emergency flood control mode would begin or continue until Recovery is complete. The following operations (Table 5) are suggested to continue to operate in emergency flood control mode:

Sequence for Achieving Normal Operating Ranges

It is not possible to describe the sequence of operational actions during Recovery prior to a particular storm event. The sequence of operational actions will depend largely on the rainfall distribution and rainfall amounts resulting from the storm.

Table 5.

Structure	Status
S-331	Pump when downstream conditions allow
S-332D	Continue to pump
S-175	Use of this structure would be on a case-by- case basis with concurrence from the Department of Interior.
S-197	Open depending on conditions
S-332B	Resume pumping according to proposed operational criteria. Unless ENP and FWS concur, weir may overflow for no more than one week.

4. Back to Normal Mode (Operational regime in place prior to the storm)

The following conditions must be met before ceasing emergency flood control mode and resuming normal mode:

1. DOI will advise the Corps of any overflow problems or adverse impacts to the CSSS Subpopulation F that may be occurring for the Corps to use in their decision regarding pumping reductions at S-332B.
2. Otherwise, stages in canal reaches must be within the specified operating ranges in place prior to the change to pre-storm or storm operations to resume normal mode.

Once these conditions are met, the normal mode, as defined by operational regime in place prior to the storm, may be resumed. Emergency use of certain water control structures, such as S-175 and S-332B, would cease.

This document may be modified depending on additional information, as it becomes available.

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

COORDINATION ACT REPORT

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

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September 28, 2001

Colonel James G. May
District Engineer
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Re: Interim Operational Plan: Central and South Florida Project; Fish and Wildlife Coordination Act Report, Multiple Counties

Dear Colonel May:

The Florida Fish and Wildlife Conservation Commission has reviewed the new preliminarily recommended plan (Alternative 7) of the U.S. Army Corps of Engineers (COE) for the referenced project, and provides the following comments and recommendations. This Coordination Act Report (CAR) is being submitted under the authority of the Fish and Wildlife Coordination Act (FWCA) of 1973.

The Interim Operational Plan (IOP) for the Central and South Florida Project was developed in response to a Jeopardy Opinion issued on February 19, 1999 under the Endangered Species Act by the U.S. Fish and Wildlife Service (FWS) for the endangered Cape Sable seaside sparrow. The opinion declared that the continuation of Test Iteration 7 (Phase I) of the Experimental Program of Water Deliveries to Everglades National Park would jeopardize the possibility of recovering this subspecies of seaside sparrow. The biological opinion developed by the FWS and adopted by the COE included a reasonable and prudent alternative (RPA) whereby jeopardy could be avoided. Upon review of the suite of alternatives presented in the COE's February 2001 draft Interim Operational Plan Environmental Impact Statement (EIS), the FWS determined that none of the available alternatives (including Alternative 6) would be likely to provide for water management operations in South Florida that would comply with the February 1999 RPA and incidental take statement requirements for the sparrow. For a detailed description of the RPA and the process that led to its development, please refer to our previous preliminary CAR to Colonel James G. May, dated April 9, 2001. Consequently, closed-door discussions ensued between the COE, FWS, National Park Service, and the South Florida Water Management District, utilizing the U.S. Institute for Environmental Conflict Resolution, in an effort to reach consensus on an IOP alternative amenable to all four parties. These negotiations ultimately resulted in the adoption of Alternative 7 as the new preliminarily recommended plan, and it is to be formally presented in a Supplemental Draft EIS that is scheduled for release later this month.

This report will focus on the performance of the new preferred alternative, Alternative 7, an outgrowth of Alternative 6. The majority of differences between these two alternatives concern the operation of water levels in canals along the eastern perimeter levee system in Miami-Dade County and operating criteria for the two S-332B seepage reservoirs. The northernmost water management structures for which operating criteria have changed include the S-335 structure on the L-30 Canal near the southeast corner of water conservation area (WCA)-3B and the two new S-355 structures located in the L-29 levee between WCA-3B and the L-29 Canal. Under Alternative 7, the use of the S-335 structure would be allowed for water supply releases when there is downstream capacity consistent with pre-ISOP (Interim Structural and Operational Plan) operations and no WCA-3A regulatory releases are being made to the South Dade Conveyance System or Shark Slough. When WCA-3A regulatory releases are occurring through the S-151 structure, then the S-335 outflows would be matched with the inflows from the S-151 and S-337 structures so as to not unduly lower canal stage levels in the L-30 Canal. The operation of the two S-355 structures has been changed such that they are opened only when the headwater stage in WCA-3B is greater than the tailwater stage in the L-29 Canal. An added structural component to Alternative 7 is the removal of the lower 4 miles of the L-67 Extension Levee. Canal water levels in the L-31N and stage criteria for S-332B pump operations have also been raised above those levels previously proposed. The operational criteria for the S-332B seepage reservoirs has been modified to include specific storm-related actions to ensure that overflow does not occur which would result in the discharge of untreated surface water directly into Everglades National Park.

For a detailed description, analysis, and evaluation of the other alternatives considered for the IOP, and our concerns about the overall coordination process, please refer to our previous report dated April 9, 2001. In terms of coordination with the COE, the overall process has shown little improvement. We have learned that negotiations were occurring between COE staff and other non-federal entities concerning IOP operations in early June. This has demonstrated the COE's willingness to consult with other interests outside the "federal family" during the development of this preferred IOP plan, while still excluding our agency from these discussions. Furthermore, we had established a process whereby we would be formally noticed as soon as a final alternative had been decided upon by the FWS, ENP, and COE staff, but we did not receive this notification until September 17, even though the preferred plan was supposedly agreed upon by August 1. We assume that our interpretations of the model output contained in our previous preliminary CAR were correct, and remain applicable, since we have received no response indicating otherwise from the COE.

We find that this new preliminarily preferred alternative is unlikely to significantly affect fish and wildlife habitat in Lake Okeechobee, Holey Land and Rotenberger wildlife management areas, WCA-1, or northern WCA-3A differently than either Alternative 6 or how the system was operated during ISOP 2000. A review of relevant model output for WCA-3A and WCA-3B suggests that Alternative 7 yields essentially the same hydrological results as did Alternative 6. The somewhat deeper water conditions following wet years in eastern and southern WCA-3A, and in western WCA-3B remain. However, we have learned that the hydrological modeling results posted for eastern WCA-3B should be viewed with caution, since they may not accurately reflect operations conducted under ISOP during this past year. It is stated that the currently preferred alternative will comply with the water management guidelines for the L-30 canal upstream of the S-335 structure that were being followed prior to the implementation of ISOP operations. We are in agreement with the operational guidelines described under Alternative 7 for the S-335 structure. The failure to maintain appropriate canal stages in conjunction with the new proposed water releases through the S-355 structures during or prior to drought events could lead to a decrease in hydroperiods, an increase in the invasion of exotic plants, and an increase in the risk of peat fires in both WCA-3B and the adjacent Pennsuco wetlands. This integration of WCA-3B into the Everglades water conveyance system should include the adoption of a water regulation schedule or a set of water level criteria to ensure that the environmental integrity of this area is not compromised. We further understand that the proposed operational criteria for the S-335 would help reduce pumping demands at the S-332B and S-332D structures, thus reducing the likelihood of overtopping the weirs of the S-332B reservoirs or of adversely impacting subpopulation C of the Cape Sable seaside sparrow. Additionally, with these S-335 operations, the demand for delivering excess water to the C-111 basin should be reduced, which we hope would result in drier conditions in the critical habitat of subpopulation D of the Cape Sable seaside sparrow, located primarily west of the C-111 Canal on the Southern Glades Wildlife Management Area.

Although modeling results appear inconclusive, based on local topography we believe that the removal of the lower 4 miles of the L-67 Extension Levee may produce slightly longer hydroperiods in the habitat of Cape Sable seaside sparrow subpopulation E, may slightly improve the capacity of the S-12D structure to move water out of WCA-3A, and may lead to slightly drier conditions in central Shark River Slough. We understand that hydrological results predicted by the 2x2 South Florida Water Management Model may not be very reliable near canal boundaries; nonetheless, we believe that the maintenance of higher canal stages in the L-31N Canal and the concomitant reduction in pumping at the S-332 structures should benefit sparrow habitat in subpopulations F and C. In conclusion, we are pleased that a suitable IOP alternative has been agreed upon whereby the Endangered Species Act requirements for the Cape Sable seaside sparrow will be met, while keeping adverse impacts to the remainder of the Everglades ecosystem at a low level.

We understand that you are in the process of developing a supplemental draft EIS that will take the description and analyses of actions taken during ISOP 2000 and incorporate them into the IOP Environmental Impact Statement. Consequently, we may wish to provide additional comments in a supplement to this FWCA Report, if appropriate.

Sincerely,

Bradley J. Hartman

Bradley J. Hartman, Director
Office of Environmental Services

BJH/DTT
ENV 2-16
a:\IOP_Prelim_CAR_SEP01.fin.wpd
cc: Mr. Jay Slack, FWS, Vero Beach
Superintendent Maureen Finnerty, ENP, Homestead
Ms. Heather McSharry, FWS, Vero Beach
Environmental Branch, COE, Jacksonville

Memorandum For Record

DATE: 28 September 2001

SUBJECT: USFWS CAR dated 2 August 2001

FROM: Richard E. Punnett, Ph.D.

1. I have reviewed the USFWS CAR and discussed the contents with others in our Hydrology and Hydraulics Branch who are knowledgeable on modeling and on the CSSS issues, and had independently reviewed the report. We generally agree that many deficiencies, contradictions, and inaccurate statements were made concerning the hydrology as a result of heavy reliance on an incomplete and inaccurate draft report by ENP (discussed below). This memorandum does not serve as a complete review of the CAR but provides a basic list of the problem areas.

2. In January, 01, ENP presented an evaluation of ISOP as a short paper. The short paper was reviewed by me and by SFWMD hydrologist (Dr. Ken Tarboten), independently. Both reviews concluded that the data provided did not support any conclusions regarding the efficacy of ISOP operations. At that time, I believed a technical discussion, using the short paper as a basis, would not be productive (e-mail from me dated 15 February 01 to Col. May, Attachment 7 of the CAR). I did recommend that the short paper be reviewed by another agency.

3. In March of 01, I learned from SFWMD that the ENP was working on a new report of the same subject. On 8 March 01, I e-mailed Dr, Sherry Mitchell-Bruker, ENP hydrologist, that the new effort provided an excellent opportunity to work cooperatively and that we could avoid "dueling documentation" (Appendix 1). I further indicated that Mr. Lan Do, Corps hydrologist, would be the point of contact for the collaborative work. On 9 March 01, Dr. Mitchell-Bruker concurred in a very positive manner (Appendix 2).

4. Over the next couple months, Mr. Lan Do made several attempts at coordination both in person during meetings and by e-mail (e.g. 20 March 01, Appendix 3). However, all Mr. Do's attempts were ignored. On 11 June 01, we were provided <u>what seemed to be</u> a final report from ENP on the ISOP effectiveness and Dr. Mitchell-Bruker was listed the primary author.

5. On 26 June 01, Col. May e-mailed Ms. Maurine Finnerty (ENP Superintendent) to confirm whether or not the product was a final or draft and also asked if she would confirm this either by letter or e-mail (Appendix 4). On 26 June 01, Ms. Finnerty e-mailed Col. May (Appendix 5) to confirmed it was "an internal draft for [our] review."

6. Since that time we have been conducting a review of the ENP draft, working on our part of the report, and working closely with ENP and USFWS on a collaborative effort to develop a recommended IOP plan. As part of that effort, we received the USFWS CAR, dated 2 August 01, and were dismayed to see that USFWS heavily relied upon the draft ENP report for parts of the CAR. This is very unfortunate because the report was only a draft that contains only part of the full evaluation. Because it is an incomplete picture, the conclusions (especially in Chapter 4) will change when mistakes are corrected and all relevant data is included. Since, the draft ENP report did not provide the RPA targets for the year 2000, no determination about whether or not the ISOP met the RPA was possible in the draft report.

7. In very dry years, like 2000, such determinations are difficult because there are very minor, if any, differences in eastern subpopulation hydrology between the 1995 base conditions and the RPA. This can be seen in the many plots of Stage Hydrographs (dry years) and in the Discontinuous Hydroperiods (the right sides of the plots). Furthermore, the final evaluation cannot be made until the RPA targets are determined for the CSSS eastern subpopulations C, E, and F. The USFWS RPA requires that "The Corps must implement actions that would produce hydroperiods and water levels in the vicinity of Cape Sable seaside sparrow subpopulations C, E and F, equal to or greater than those that would be produced by implementing the exact provisions of Test 7, Phase II..." In response, the Corps implemented actions (ISOP operations) to produce the required hydroperiods and water levels for those subpopulations. However, the actual targets for 2000 remain elusive but can be estimated as soon as the modeling database is updated to include 2000 data.

8. Because the hydrology that would be produced by Test 7, Phase II, would vary each year depending on weather patterns, the RPA targets vary each year and cannot be known in advance or even during events. Therefore, the only way to evaluate potential water management actions would be to model the RPA requirement over a 31-year period of record. Then, using the modeled targets, potential ISOP and IOP actions can be evaluated for equivalence. In support of the evaluation of ISOP, the SFWMD is updating the modeling database to include the years 1996 to 2000. Once the update is complete, then model runs can be made to determine the RPA targets and comparisons to ISOP modeled results can be made. This, together with field data, can be used to determine whether or not ISOP operations met the RPA requirements.

9. On many occasions last fall, the ENP stressed the need to have modeling efforts peer reviewed. Even though the model used for ISOP/IOP evaluations (the SWFMM version 3.8) was peer reviewed, the ENP declined (in November 00) to evaluate model runs from version 3.8.1 because that version had routines not peer reviewed. Runs from version 3.8.1 were later removed from consideration for that reason. In the ENP draft report and in the CAR, numerous references were made to both MODBRANCH and GFLOW. Neither of these applications have been peer reviewed – in fact, the GFLOW model was never provided to us and its use was a complete surprise. Thus, we have no basis of comment about the GFLOW application except

that it is generally used for approximations and not rigorous model predictions. We will make every effort to complete an evaluation of the GFLOW application in the near future.

10. We have reviewed the ENP input for MODBRANCH, but we have serious concerns that have not been addressed. The MODBRANCH application by ENP used a canal to represent the seepage reservoir at S-332B. The one of soil properties used in the ENP application was more than 30 times the values we suggest based upon field data. The "reservoir," as modeled by ENP, has an 18-foot deep channel down the middle of the "reservoir" into the lower ground strata. Although it may be needed to create model stability, it further departs from reality.

11. A great concern about the ENP application of MODBRANCH is the fact that no weir was included and therefore no reservoir overflow was modeled (although needed to evaluate ISOP). This would lead to a gross underestimate of the efficacy of ISOP – particularly in one of the wettest years in the modeling database (1995 was used in ENP analysis). Furthermore, the S-332B pumping criterion was devised by the ENP and is contrary to the actual ISOP operations. The need for overflow has lead to an agreement between agencies to expand the seepage reservoir in the near future to avoid the need for overflow. Instead of concluding ISOP does not meet RPA requirements, ENP should have concluded – as we did in the summer of 2000 – that overflow is needed to meet the RPA requirements with the current seepage reservoir.

12. Another great concern with relying MODBRANCH is the fact that it does not properly model overland flow. This is not normally a problem since most applications are for groundwater investigations and that is what MODBRANCH was meant to do. However, in evaluations of ISOP and RPA, surface water is the paramount concern. It is hydroperiods, the time water is above ground, that strongly influences the kinds of plant communities that will grow and that determine fire prevention conditions. MODBRANCH does not have overland flow equations and is not reliable in predicting conditions surface water flows in Shark River Slough or its adjacent areas. There are other models that will properly and reliably handle both surface and groundwater flows, however MODBRANCH will not.

13. References in the ENP draft report should not include SFWMM version 3.8.1 since it was not used to determine ISOP or IOP operations. Both the MODBRANCH and GFLOW models were compared to version 3.8.1 (a version not used for ISOP or IOP). Thus, any conclusions from both MODBRANCH and GFLOW models have no comparisons to the way ISOP was modeled and implemented.

14. Many other points require changes to both the CAR and ENP draft report. Several are listed here. The draft report failed to mention that both the "natural" and "restored" conditions will be less conducive to the western sparrow nesting (i.e. more nesting failures) than the 1995 base, ISOP, or IOP conditions. The draft used an incomplete set of RPA requirements to evaluation the ISOP effectiveness for the western sparrow subpopulation. The analysis of recession rates at NP-205 is in error

because it does not recognize the difference between surface water and equivalent pore space in the ground. Some data are presented without explanation of source or validity. Some figures in the draft report do not have legends. Some figures show improvement for the sparrow although the text states otherwise. Some figures are reported to show something it does not and/or has errors (e.g. Figure 4.40). Some erroneous statements were made as to why L-31N and C-111 canal levels were set. The evaluations of salinity using the predicted stages at P-33 is totally unreliable since the flow patterns to Florida Bay are far more impacted by flow changes in Taylor Slough. The use of P-33 stages was originally based upon an historical correlation that assumed no changes to Taylor Slough flows. Some of the contour plots in the draft report do not represent reality although presented as real data (e.g. Figures 4.20 and 4.23). When reporting on the exceptional rainfall event of April 2000 at NP-205, the draft report incorrectly attributes NOAA data as "Corps estimates."

15. A simple, but important, hydrologic evaluation was referenced by me in my 15 February 01 e-mail (Attachment 7 of the CAR) which characterized stage improvements in the sparrow regions E and F. However, there was no attempt to include that information in the draft report. Curiously, my 15 February e-mail was included in the draft but no mention of the apparent benefit of ISOP that it provided was mentioned in the body of the CAR. An additional curiosity is that none of the other e-mails relating to the agreement to develop a joint report and initiating the effort (from me, Dr. Mitchell-Bruker, and Mr. Do) were referenced in the CAR.

16. It is clear that the August 2, 2001, CAR evaluation relied upon a June 11, 2001, draft report that was not only incomplete but contained many flawed conclusions about the hydrologic conditions related to ISOP. While Chapter 4 of the CAR relied most heavily on the draft report, other sections of the CAR reference back to the Chapter 4 analysis.

17. The CAR provides convincing evidence that the ISOP met the CSSS requirements for the western subpopulation A. The BO states that the Corps' actions should include "steps to bring NP 205 water levels down below the target [6.0 ft] in order to provide a buffer that would allow **normal rainfall** [emphasis added] to occur without bringing NP 205 levels back above the target..." CAR Figure 4.75 shows that under ISOP operations, the water levels in the area were well below average, prior to the April 2000 event, even though: (1) a near record high stage from Hurricane Irene occurred 6 months earlier; and (2) that (page 113 of the CAR), "Under all drought measures, April 2000 is wetter than normal."

18. Although not explicitly stated, the CAR also provides convincing evidence that the ISOP may have met the CSSS requirements in the eastern subpopulations. In addition to showing good nesting conditions, data from several gages in NESRS show that water levels were at least equal to the historic average even though the year 2000 was a drier than average year. The gages are NE 1, NE 2, NP 206, G3273, RG 2, and RUTZKE (CAR Figures 4.73, 4.72, 4.78, 4.81). If a line connected these gages, it

would form a polygon around NESRS and be tangential to subpopulations E and F. For subpopulation E, the CAR states on page 146, "The hydroperiods were slightly above the 180 day maximum for long-term sustenance [for] suitable CSSS habitat." Ironically, if ISOP operations had been more effective in NESRS, it would have been too much!

19. Neither the ENP draft report nor the CAR recognize the extreme efforts the Corps made to provide for the sparrows when the data show many positive results were achieved. The Corps implemented ISOP in late 1999, soon after a record setting high water event (Hurricane Irene), and was able to provide dry conditions for the spring nesting season in all CSSS subpopulations. Then, the Corps actions reversed the drought effects that occurred during the summer of 2000 to provide wetter than average conditions in the CSSS subpopulations. This kind of responsive large-scale water management was not recognized by the CAR.

RICHARD E. PUNNETT, PhD

APPENDIX 1

Subject: ISOP analysis

Author: "Punnett; Richard E SAJ" <Richard.E.Punnett@saj02.usace.army.mil>
Date: 3/8/01 9:19 AM

Sherry,

I feel we have an excellent opportunity for a cooperative effort in evaluating the efficacy of the ISOP. According to your e-mail of March 3, you are "currently working on a more complete and well-documented report" on your analysis of the ISOP. Since this has not been completed/distributed, I suggest we jointly develop the final product. That way we can obviate the possibility of creating dueling documentation on this issue. We could combine our evaluations and make it a single definitive report.

If this is possible, please provide us with a draft copy and we can begin immediately reviewing and combining our evaluations. Lan Do can serve as out point of contact on this matter. What do you think?

Richard

APPENDIX 2

From: Sherry_Mitchell@nps.gov on 03/09/2001 05:20 PM

To: Richard E Punnett/CESAJ/SAJ02@CESAJ
cc: Thomas_Van_Lent@nps.gov@SMTP@Exchange, Maureen_Finnerty@nps.gov@SMTP@Exchange, Robert_Johnson@nps.gov@SMTP@Exchange, James G May/CESAJ/SAJ02@CESAJ, Heather_McSharry@fws.gov@SMTP@Exchange, james@ever.nps.gov@SMTP@Exchange, Lan V Do/CESAJ/SAJ02@CESAJ, Michael L Choate/CESAJ/SAJ02@CESAJ, Cheryl P Ulrich/CESAJ/SAJ02@CESAJ, Ken Tarboton <ktarbot@sfwmd.gov>@SMTP@Exchange, Stephen_Forsythe@fws.gov@SMTP@Exchange, dworth@sfwmd.gov@SMTP@Exchange
Subject: Re:ISOP analysis

Richard,

Your suggestion of a joint effort on the evaluation of ISOP performance is a good one. It would, I think, help us discuss the technical issues in a constructive and positive way. We sincerely appreciate this suggestion, and would definitely like to work together.

Of course, for a successful outcome, it would help to have mutual understanding on several fundamentals. First, it is essential that if we are going to cooperate on this effort, both parties must act from a position of mutual respect, recognizing the expertise and mission of the other. Along this same line, it is important that we both acknowledge that the hydrologists at both Everglades National Park and the Jacksonville District are qualified to make judgements regarding the reliability of model results, analysis of field data, and analysis of the operation of the C&SF project. I raise this issue because of recent correspondence (Jan 22, 2001) and your e-mail to Col. May indicating that "there is little to gain in a technical discussion between our two agencies on this matter". I am committed to the dispute resolution process and I have refrained from continuing technical discussions that the Corps might find unwelcome. I will take this offer for a joint report as positive indication of your willingness to participate in further technical discussions in a constructive way.

I suggest that we would need an ongoing dialogue to answer questions and air differences of opinion, acknowledging that scientific discourse includes disagreement. The final document may require a section pointing to areas where the Corps and ENP have differing conclusions. How we resolve those differences remains an area that I believe we need to clarify.

I intended to produce a National Park Service SFNRC Technical Report. In the event that we cooperate on this report, I would suggest we produce a National Park Service SFNRC Technical Report, produced in cooperation with the USACE, Jacksonville District. This would be a first and I believe a significant breakthrough.

Finally, based on the success of some of my past collaborative efforts, I suggest we meet, agree on a report outline, agree on analytic tasks, exchange reports on analysis and then meet to compile these reports into a single document.

I plan on having a first draft of this document assembled by April 2. Therefore we would have to act quickly in order to make this happen. Please let me know as soon as possible if you think that we can make this cooperative effort work and how you would like to proceed. I look forward to a congenial and productive collaboration.

Sincerely,

Sherry

****
Sherry Mitchell-Bruker, Ph.D.
Research Hydrologist
Everglades National Park
40001 State Road 9336
Homestead, FL 33034-6733

Phone: 305-242-7886
****

APPENDIX 3

Author: Lan V. Do
Date: 03/20/01 7:26 AM

To: Sherry_Mitchell@nps.gov@SMTP@Exchange
cc: Thomas_Van_Lent@nps.gov@SMTP@Exchange, Maureen_Finnerty@nps.gov@SMTP@Exchange, Robert_Johnson@nps.gov@SMTP@Exchange, James G May/CESAJ/SAJ02@CESAJ, Heather_McSharry@fws.gov@SMTP@Exchange, james@ever.nps.gov@exchange, ktarbot@sfwmd.gov@exchange, Michael L Choate/CESAJ/SAJ02@CESAJ, Richard E Punnett/CESAJ/SAJ02@CESAJ, Russell Weeks/CESAJ/SAJ02@CESAJ, Cheryl P Ulrich/CESAJ/SAJ02@CESAJ, Stephen_Forsythe@fws.gov@SMTP@Exchange, dworth@sfwmd.gov@SMTP@Exchange
Subject: Re:ISOP analysis

Sherry,

I hear that there will be a modeling session on the next version of the SFWMM between the ENP and the SFWMD at the management district office in West Palm Beach on the 23rd of March. I would like represent the Corps of Engineers at this modeling session and hopefully, it will be a start for the joint effort on the evaluation of ISOP performance. I believe that a cooperative effort among ENP, SFWMD, and the Corps on solving technical issues regarding the SFWMM is always constructive. I suggest that we should start this joint effort on the ISOP evaluation immediately by taking advantage of this opportunity.

Lan

APPENDIX 4

"May; James G SAJ"<James.G.May@saj02.usace.army.mil>
Date: 06/22/01 11:53 AM MDT

To: Maureen Finnerty/EVER/NPS
cc:
Subject: Draft Report

Maureen,

Enjoyed seeing you yesterday. The dialogue will be very helpful in shaping the next steps!

Per our discussion, I would greatly appreciate a letter or email from you indicating that the analysis of the ISOP your staff sent to my staff is only a draft document for our review. In the spirit of the great progress being made in the facilitated meetings, we'd welcome the opportunity to work with your staff in some capacity for future permutations of this information.

On a personal note, my wife and I are going to be in South Florida on vacation next week and the Park is one of our major destinations. If you're in next week and not busy, I'd like to introduce you to Kanda.

Greg

APPENDIX 5

From: Maureen_Finnerty@nps.gov on 06/26/2001 10:38 AM

To: James G May/CESAJ/SAJ02@CESAJ
cc:
Subject: Re: Draft Report

Greg, great seeing you and Kanda yesterday. The ISOP information you received was an internal draft for your review. Let's keep moving forward!

maureen

USACE Comments on Coordination Act Report dated August 1, 2001, for the Interim Operational Plan for Protection of the Cape Sable Seaside Sparrow.

Water Quality Responses

Page 53. Third paragraph, first sentence. "The phosphorus loads in kilograms of phosphorus were calculated for S-332B by using the mean phosphorus concentration (in mg/l) from the Corps' preliminary water quality data for January and March 2000 at the automatic sampler in L-31N downstream of S-331."

Response: The Corps' water quality data collected prior to June of 2000 was reviewed by FDEP and considered by them to have a positive bias of 16 ppb. The Corps does not agree with the FDEP position that there is a bias. However, in order to move the discussion forward, we utilized only data collected and analyzed in June, 2000 and afterward. It appears that the TP load calculations shown in this CAR are inadequate to differentiate the alternatives, because the dataset used was too small to calculate average TP concentrations or indicate full seasonal fluctuations.

A better way to rank the alternatives by water quality impact is to calculate the monthly 2-year return flow at each structure and multiply this by the monthly average TP concentration and then compute an annual TP load estimate. Since the SFWMD water quality database has a longer period of record at all structures except S-332B, this data set should be used where possible to calculate monthly mean TP concentrations.

Page 53. Last paragraph. Last sentence. "Phosphorus load discharges into NESS and southern Shark Slough are marsh ready and therefore higher load is equal to better alternative performance."

Response: How can "higher load" equal better alternative performance for NESS and southern Shark Slough discharges? Has a performance measure for optimum TP load delivery at NESS been established? If not, this statement does not appear to be supportable. At a minimum, the characteristics of TP delivery at NESS should be demonstrated by the calculation of: the min/max TP concentration, geometric mean TP concentration, flow-weighted average concentration, standard deviation of TP concentration, and coefficient of variance. A comparison with Taylor Slough TP load characteristics could then be made to see if this water is substantially different from "marsh ready" TP loads from NESS.

Page 54. First Paragraph. First sentence. "...discharges from S-332B, S-332D, and S-18C, if left untreated, will likely exceed the flow-weighted mean concentration phosphorus limit specified in the MCD."

Response: The above statement is not proven by the analysis presented in this document. This statement makes it appear that the S-332B pump discharges directly to ENP/Taylor Slough. This is not true. The S-332B pump discharges to the S-332B detention area. If the settlement agreement calculation of discharges to Taylor Slough is modified to take into account operation of S-332B, the proper structure at which to measure flow and water quality is the S-332B overflow weir. This weir directly discharges into ENP/Taylor Slough. Discharges at the S-332B weir occurred in September and October of 2000. The MCD calculation for Taylor slough was made for two 12-month periods, one ending October of 2000 and one ending in November of 2000. Calculations were done for just S-332D/S-174, S-18C discharges and S-332B weir discharges. For the two periods analyzed, including the S-332B Weir discharges increased the average flow-weighted TP concentration from 8.1 ppb to 8.7 ppb, a value lower than the 11 ppb standard set by the MCD.

Page 135. Paragraph 1. 3rd sentence. "At the same time that WCA-3B was being drained, S-332B was overflowing, delivering high concentrations of phosphorus to ENP."

Response: P concentrations measured at the S-332B pump structure are not the same as P concentrations measured at the overflow weir. The former measure P concentrations at the intake to the detention area, while the weir P concentrations measure P at discharge to ENP. The average flow-weighted TP concentration at S-332B weir for the October, 2000 overflow event was approximately 22 ppb. During this same time, the average flow-weighted TP concentration at S-332D was 24 ppb as calculated using Corps' data, and 24 ppb as calculated using SFWMD S-332DAS data. Even when these total P numbers are incorporated into the flow-weighted yearly moving average TP concentrations for the Taylor Slough/Coastal Basins, the average was below 10 ppb.

Page 135. Paragraph 2. 2nd and 3rd sentence. "In essence this wet season operation used S-332D to route flood waters from WCA-3B, the Pennsuco Wetlands, NESS, and the 8.5 SMA into ENP. In a water quality analysis, included in Appendix B, ENP staff have reviewed data provided by the Corps and concluded that these flood discharges contained high levels of phosphorus that could lead to changes in vegetative communities in ENP".

Response: Appendix J of the C-111 GRR (Corps 2001, draft version) includes an analysis of water quality data for the 10.5 in rainfall event of October 3rd, as well as for 8 moderate storm events (precipitation greater than 1 inch in 24 hours) that occurred between June and November of 2000. The Corps concluded that the 10.5 inch rainfall event of October 3rd delivered a disproportionately high load of TP to ENP. This rainfall event has return periods in excess of 1 in 15 years (it was a very infrequent event). However, the Corps' analysis shows that moderate rainfall events do not deliver a disproportionate load of TP to ENP.

Page 163. Section 4.8. First Paragraph. Last sentence. "This will reduce the dilution effect at S-18C, increasing the phosphorus levels at this structure."

Response: This sentence is not completely accurate. Flows through S-18C are only reduced during large storm events. The alternative to reduced storm flow through S-18C is the increased possibility of flows through S-197.

Page 163 bottom, Page 164 top, Figure 4.93. "Raw data from August,1999, January 2000, March 2000...."

Response: The data used here (data collected prior to June 2000) are not being used by the Corps to calculate average TP concentrations because they are under review by FDEP. Using June through November 2000 data, the Corps calculated an average TP concentration at S-331 of 10 ppb and at S-332D of 11 ppb. These values differ greatly from those displayed in Figure 4.93 which shows 15 to 25 ppb for these two structures.

Page 164. First paragraph. Last sentence. " There also appears to be some seasonal (wet season/dry season) effect.

Response: The Corps belives there are not enough data in the Corps' dataset to make this statement. The SFWMD dataset is more appropriate for estimating seasonality.

Water Management responses

The implementation of changes to operations to benefit the Cape Sable seaside sparrow (CSSS) has provided a challenge to the agencies responsible for management of the water resources of the Central and Southern Florida Project (C&SF). The C&SF project is multipurpose in scope and includes flood control, water supply and conservation and conveyance of water to Everglades National Park. These purposes often are in conflict depending on the hydrologic and meteorological conditions at any given time. Figure 1, a hydrograph of water levels in Water Conservation Area 3A and 3B (WCA-3A) for the period 1963 through 2000 provides an overview of the higher than normal stages in WCA-3A during the 1990's.

Figure 2 is a closer view of WCA-3A and 3B water levels from 1999 to 2001 showing the relative amounts of water in the system prior to Hurricane Irene in Oct 1999 and the Oct 2000 event into the 2001 nesting season. The CAR indicates concern over water levels in L-30 as indicated by the headwater of S-335 (FWS/NPS 2001, p. 83, figure 4.8a). It is interesting to note that overall the system was "full" as indicated by water levels WCA-3A in 1999 and the nesting season of 2000, while much less so going into the nesting season of 2001. The operation of S-335 was as stated in the March 2000 EA(ISOP 2000). S-335 may be opened with the goal of achieving a 6.0 ft-NGVD headwater upstream of S-335, before water is introduced via S-334. The operation of S-335 was not inconsistent with the plan of having water levels such that water could be moved via L-30 and L-31N when needed.

The difference between the RPA and IOP is that the RPA seeks to move water into areas still in private ownership, or raise canal levels without providing protection against increased water levels. The ISOP and IOP seek to provide the hydrologic requirements of the sparrow while still meeting other project purposes such as flood control and water supply. Since implementation of the Experimental Program of Water Deliveries to Everglades National Park in 1984, water levels in the L-29 canal which supply water to NESRS have been 2.5 feet higher than the design optimum of 5.0 ft-NGVD. With the completion of culvert structure G-211, the reach between S-335 and S-331 has been held, on average, 1.0 ft higher than the design optimum of 5.0 ft-NGVD. These changes have occurred in an effort to address concerns over lost seepage from NESRS to the east, and have had the effect of raising water levels in NESRS, which is considered a benefit to ENP. Stages in the L-30 canal north of S-335 have also been higher than the design optimum, due to downstream conveyance limitations.

The benefit of the ISOP for the reach of L-31N south of S-331 is the movement of water to the west toward ENP by pumping at S-332B and S-332D, as indicated by modeling, to meet CSSS requirements. Concern over lowering of the canal is compensated by pumping at S-332B. DOI has raised concern over the quality of the water pumped at S-332B, however, monitoring of the water showed that the quality has remained within acceptable limits (see preceding water quality responses).

The evaluation of alternatives and recommendations in the August 2, 2001, CAR reflect Department of Interior resource concerns. Performance measures used by DOI relate only to hydrologic consequences for the sparrow, other species of special concern, ENP lands and other natural resources in the Water Conservation Areas. In contrast, Corps contraints include evaluating these factors along with requirements for flood protection, water supply and other authorized purposes of the C&SF Project.

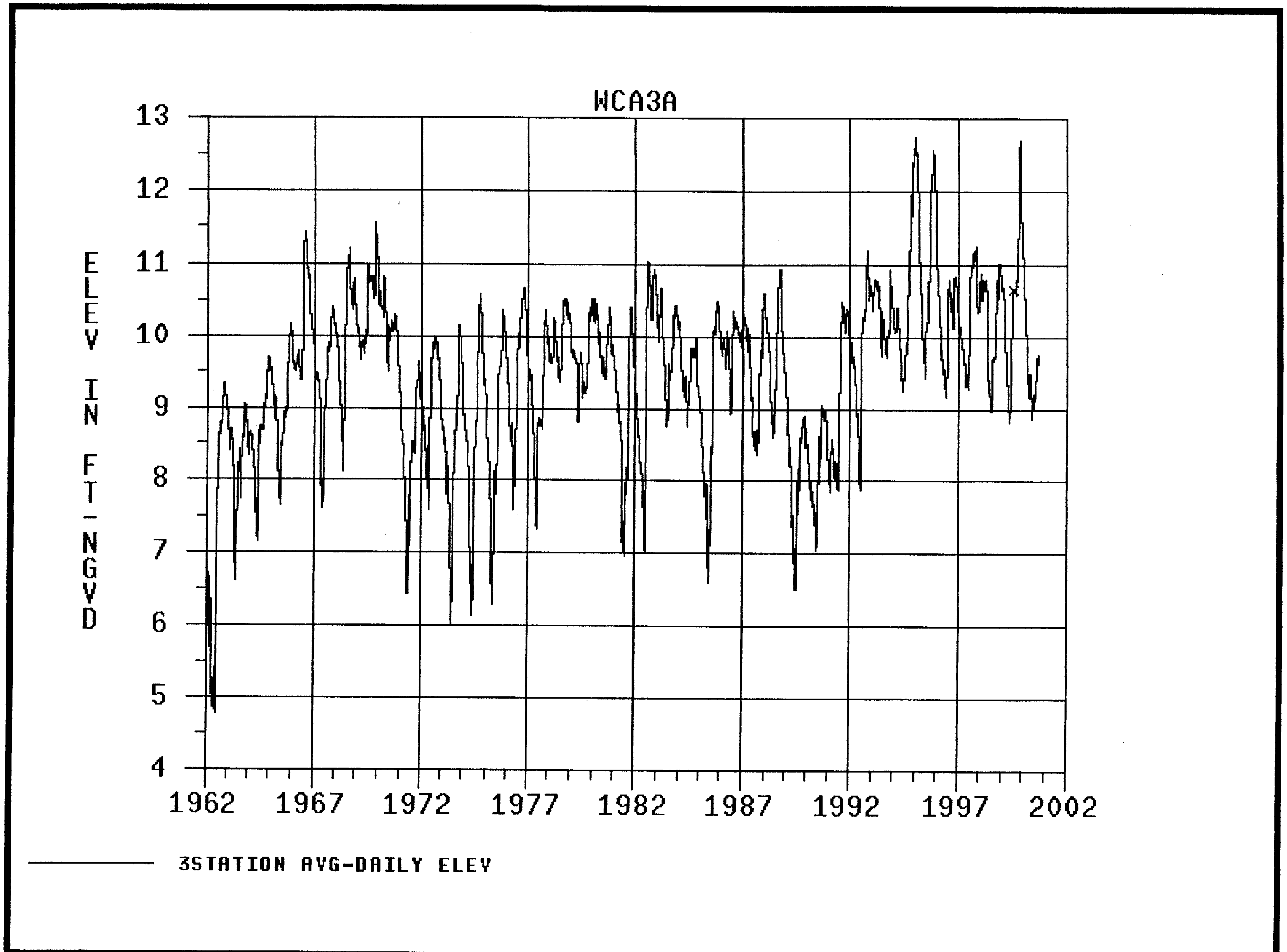

Figure 1. WCA-3A water levels.

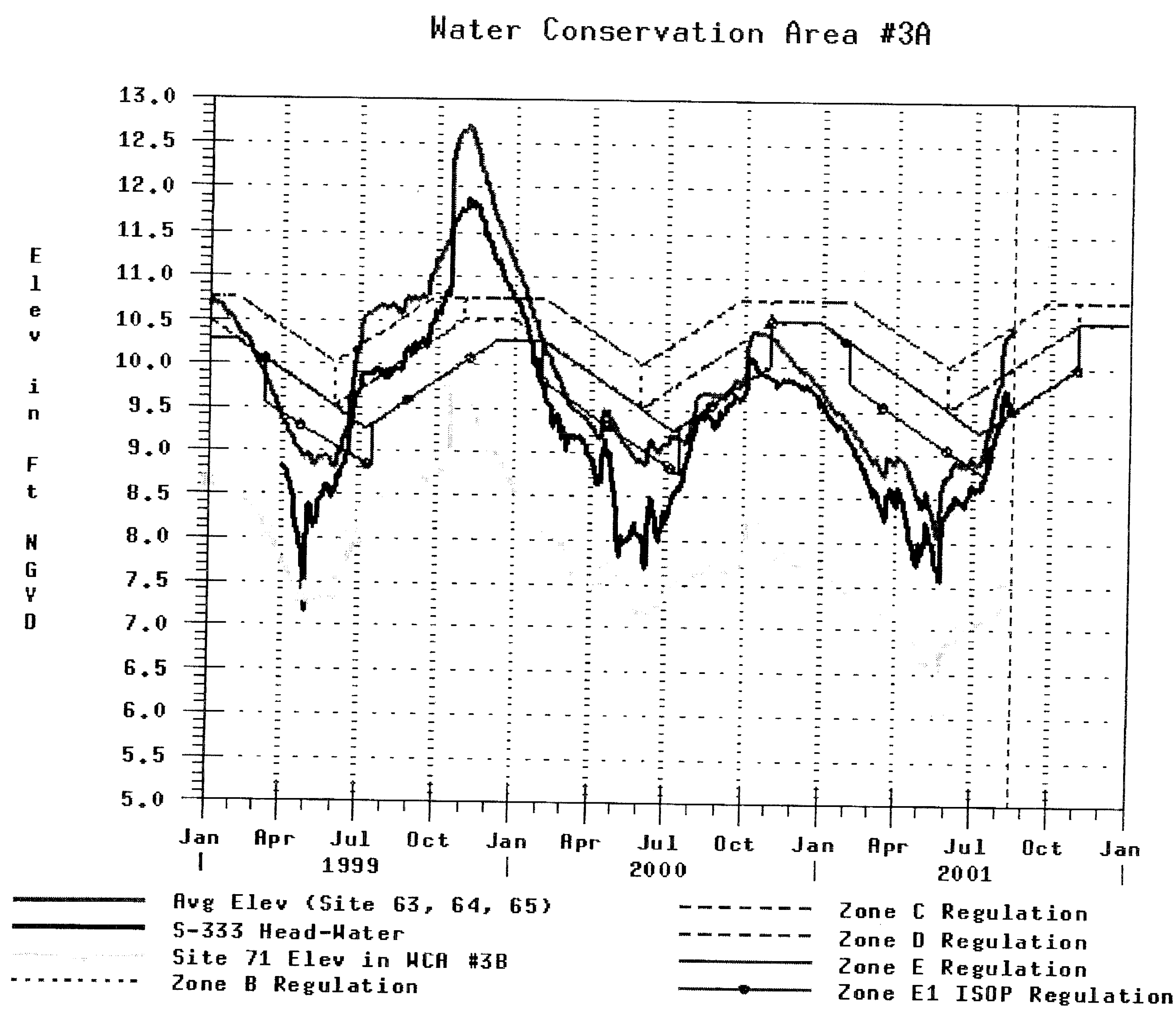

Figure 2. WCA-3A water levels 1999 through 2001. Note high water levels in WCA-3A through the wet season 1999 indicated that overall the southern portion of the C&SF system was "full".